



Natural Resource Year in Review–2003

A portrait of the year in natural resource stewardship and science in the National Park System



Restoration



Transforming
the National
Park System

The New Face
of Professional
Resource
Management

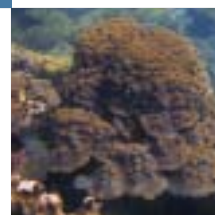


Cooperative
Conservation

Inventory and
Monitoring
Charges Ahead



Conserving
Threatened
and
Endangered
Species



Preventing
Natural
Resource
Impairment



Frontiers for
Science
and Natural
Resource
Education



“Despite changes in economic status, political upheaval, social injustices, or disasters, the national parks are always available to serve as actual or potential refuges. The parks are traditionally ‘American,’ are always welcoming, and serve as symbols of all that we value.”

—Paul G. Risser
Science and Ecosystem Management in the National Parks

ON THE COVER

The people depicted represent the multitude of professional natural resource managers and scientists who are helping to maintain nature in the national parks. The National Park Service is benefiting from recent funding from the Natural Resource Challenge to professionalize the natural resource management workforce and to increase the number of scientists doing research in the national parks. In this issue we celebrate their many invaluable contributions.

Natural Resource Year in Review–2003

A portrait of the year in natural resource stewardship and science in the National Park System

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Federally listed as endangered, the nene or Hawaiian goose (*Nesochen sandvicensis*) is resident in Hawaii Volcanoes and Haleakala National Parks, Hawaii. To protect the species, staff at the parks control nonnative predators, monitor nesting, and research species nutritional requirements. An update on threatened and endangered species in the national parks is featured on pages 80–93.



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The Year 2003 in Review

Associate Director Soukup (middle row, second from right) and senior staff of the Natural Resource Stewardship and Science (NRSS) Directorate convened in Zion National Park, Utah, in summer 2003 where Water Resources Division chief Dan Kimball (in uniform) was serving as acting park superintendent. The senior staff are (front row, left to right): Jake Hoogland (chief, Environmental Quality Division), Chris Shaver (chief, Air Resources Division), Dan Kimball; (middle row, left to right): Chuck Pettee (acting chief, Water Resources Division), Rich Gregory (chief, Natural Resource Information Division), Mike Soukup, Dave Shaver (chief, Geologic Resources Division); (back row, left to right): Loyal Mehrhoff (chief, Biological Resource Management Division), Abby Miller (deputy associate director, NRSS), and James Gramann (visiting chief social scientist).



National parks: A legacy of intergenerational commitment

by Michael Soukup

“[National] parklands are more than physical resources. They are the delicate strands of nature and culture that bond generation to generation.”

—George B. Hartzog, Jr.
Battling for the National Parks

NATIONAL PARKS are intergenerational commitments for the common good, with each generation conserving these magnificent places through restraints placed on their uses. This ethic of stewardship depends upon each generation developing a meaningful relationship with parks that translates to public support. Only with support for a commitment to parks will the character of our nation’s most important places remain *intact* and the visitors’ experience of our nation’s

heritage remain undiminished. This commitment can never be broken if our natural and cultural heritage is to be preserved for our citizens to enjoy for all time. Nothing less will pass the parks along unimpaired. Each *Year in Review* documents the year’s events, the National Park Service’s achievements and setbacks, and their effect on this commitment.

Although not the primary reason why national parks are set aside, economics reflects the wisdom of national park creation and preservation. Public investment in the National Park System produces significant economic benefits for neighboring communities and surrounding regions. In 2001, the latest year for which figures are available, this investment totaled \$1.8 billion, including congressional appropriations for operation of the National Park System, construction, the U.S. Park Police, and one-half of the land acquisition budget. According to studies conducted this year by Michigan State University for the National Park Service, the return on this investment from

visitor spending within a day's travel of parks amounted to \$10.6 billion, a yield of more than 400%.

A very positive event this year was the convening of a science committee in January by the National Park System Advisory Board. Director Mainella asked this committee to evaluate the Natural Resource Challenge and make recommendations on the future of science in national parks. The interest, time commitment, and dedication of Drs. Sylvia Earle (National Geographic Society), Shirley Malcolm (American Association for the Advancement of Science), Peter Raven (Missouri Botanical Garden), E. O. Wilson (Harvard University), Gary Paul Nabhan (Northern Arizona University), and Larry Madin (Woods Hole Oceanographic Institution) were positive demonstrations that top scientists strongly believe that national parks have an important role to play in the future environmental health of the nation, and perhaps the planet. Their report, formulated with the benefit of the land manager perspective from former Superintendent (and now Board Member) Bob Chandler, is forthcoming in spring 2004 and is something to look forward to.

An event that stands out for me this year occurred at the George Wright Society's biennial meeting in San Diego. Alan Latourelle (CEO of Parks Canada) discussed his country's plan for doubling the size of their National Park System. He said that his generation of Canadians may be the last who would be able to make a commitment to fashion a national park system that fully represents their nation's natural heritage. That reality should raise a question for us: Is our National Park System fully representative of our national heritage? If not, is there time and will to act?

At this meeting and also at the World Parks Congress in Durban, South Africa (in August)—the congress in itself is an event of the decade—the three directors of the North American park systems met to discuss common issues and new ways of working together.

Whereas the calendar year began with a substantial investment of new funding from the Natural Resource Challenge, it closed with economic, security, and other national concerns, reducing *slightly* in the FY 2004 budget the priority previously accorded this initiative. We have had great success in the last few years in tackling these problems through a number of programs collectively called the Natural Resource Challenge. The Challenge has provided science for parks. It also has provided for "parks for science" programs (research learning centers, Sabbaticals in the Parks, Internet-based research permit applications) that make parks better places for the pursuit of science. Many new Challenge-funded programs are blossoming into institutions that are transforming the National Park Service and the national parks (see page 15), including Exotic Plant Management Teams, research learning centers, Cooperative Ecosystem Studies Units, and others. However, the most critical Challenge element will be the system of 32 networks of park units that will constitute the first cohesive effort to measure management performance in protecting park resources. Of the eight monitoring networks proposed for funding in FY 2004, three networks—the Arctic, Southeast Coast, and Upper Columbia Basin Networks, serving 30 parks—were left unfunded (leaving a total of 10 unfunded networks) (see map, page 34). So far only about 70% of the critical Natural Resource Challenge information infrastructure (i.e., monitoring networks) is funded after five years, the original target


completion date of the Challenge. Law enforcement, U.S. border safety issues, and maintenance of park buildings and roads are competing and pressing priorities.

While it is easy to demonstrate that park facilities require billions of dollars to maintain, the urgency of investment needs and immediately tangible outcomes for natural resources is more difficult to appreciate. When landscapes were less dominated by human activities, less investment may have been necessary. However, today's parks must be actively managed to control the influx of nonnative plants and animals, the incursion of polluted air and water, and the loss of species as parks become isolated islands of habitat. For these reasons active investment in scientists and project support will be necessary to maintain the nation's commitment to its heritage.

Our national parks saw a number of very positive events in 2003, many of which are reported here in the *Year in Review*. They include the breeding success of California condors in Grand Canyon National Park (see page 83), the recovery of nesting waterbirds since the removal of black rats from Anacapa Island (Channel Islands National Park; see page 74), and the dedication of the new research learning center at Rocky Mountain National Park (see page 22).

Other events for 2003 have potentially important, but not as promising, implications for the future of national parks. These include the well-publicized grizzly bear attack on two frequent park visitors at Katmai National Park, numerous outbreaks of fire in natural areas that have been managed unwisely for decades (to suppress the natural fires), increased national needs for power plant construction, and the growing water quantity crisis in the West. A graphic illustration of resource management problems that require hands-on management in parks—in this case the need to manage the invasion of exotic species—was the 24-hour-long struggle between a 12-foot Burmese python (pictured on the cover) and a native alligator witnessed by many visitors to Everglades National Park. The presence of Burmese pythons (which are now apparently breeding in the Everglades) is a striking example of the changes being effected in parks by human activities. What changes will this invasive species make in the system and how will native species be affected?

Although the FY 2004 budget produced a range of events and consequences, annual budget increases over the past several years and the momentum they have built for on-the-ground stewardship efforts in parks, especially progress toward vital signs monitoring in the funded networks and in many restoration activities that reclaimed lost ground, were cause for overall optimism. ■



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Year at a Glance—2003

january

The Natural Resource Information Division launches the intranet site for NPS research and learning centers at http://www1.nrintra.nps.gov/learning_centers.

More than 60 park managers and resource specialists from western parks gather in Phoenix for the first NPS Western Energy Summit to discuss energy development planned near parks (see page 64).

Superintendents and staffs from 17 U.S. and 9 Canadian national parks designated as world heritage sites meet to begin a process of reporting on their participation in the World Heritage program and the condition of the sites they manage.

february

Director Mainella cuts the symbolic “last” melaleuca tree, an invasive species, in Big Cypress National Preserve, Florida (see page 15).

The Secretary of the Interior announces that regulations and general management plans for the protection of the new Virgin Islands Coral Reef National Monument and expanded Buck Island Reef National Monument will go forward (see page 53).

march

Director Mainella announces the winners of the 2002 Director’s Awards for Natural Resource Management.

april

The National Park Service, Bureau of Reclamation, and U.S. Fish and Wildlife Service enter into an agreement with the Colorado Water Conservation Board to resolve water rights issues affecting Black Canyon of the Gunnison National Park.

The Environmental Protection Agency announces a legal settlement with Virginia Electric and Power Company that will benefit air quality in Shenandoah National Park and the entire Mid-Atlantic region by 2015.

The final Clean Water Act permit for the Washington Aqueduct is issued and will result in significant reductions in discharged sediments and other pollutants, thereby protecting resources of the Chesapeake and Ohio Canal National Historical Park and the aquatic resources of the Potomac River (see page 70).

The NPS Fire Program, the Biological Resource Management Division, and the Colorado Plateau Cooperative Ecosystem Studies Unit sponsor a workshop for parks in the Intermountain Region on integrating fire planning with the planning and management of natural and cultural resources.

may

Staff install new meteorological monitoring stations that employ “portable ozone monitors” at Lake Mead National Recreation Area, Nevada and Arizona.

The Ecological Society of America, National Park Foundation, and National Park Service announce the National Parks Ecological Research Fellowship Program for FY 2003 through which three postdoctoral research fellowships, funded by the Andrew W. Mellon Foundation, will be awarded for research on the flora of national parks.

Park and regional staffs meet in Denver to begin testing the Planning, Environment, and Public Comment (PEPC) tracking system, a Web-based application that facilitates public review of environmental park planning documents (see page 96).

june

The third national meeting of the Cooperative Ecosystem Studies Units (CESU) Network is held in Washington, D.C., giving representatives from CESU-affiliated universities and other institutions opportunities to share their expertise and capacities with federal managers and decision makers (see page 24).

july

The Natural Resource Laureate Program gets under way with the selection of six parks to receive natural resource project assistance from volunteers with the Environmental Alliance for Senior Involvement who have a high level of technical natural resource expertise (see page 100).

The Natural Sounds Program Office, the Federal Aviation Administration, and the Department of Transportation Volpe Transportation Center initiate new air tour management plans in Yellowstone National Park, Wyoming; Glen Canyon National Recreation Area, Utah; and Navajo and Canyon de Chelly National Monuments, Arizona (see page 68).

The Biological Resource Management Division publishes a scientific assessment of the management of microbes in the context of the NPS mission, addressing such issues as the feasibility of determining the status (native or exotic) of microbes and identifying the multitude of processes involving them in the national parks.

september

A consortium of environmental organizations files suit in federal court against the Secretary of the Interior and the Director of the National Park Service challenging the legality of the April Black Canyon settlement agreement.

Director Mainella signs Director's Order 77-2 regarding the management of floodplains in parks, including development that could adversely affect natural resources and the functions of floodplains.

Judge William Hoeveler, the judge originally presiding over the settlement of the 1988 Everglades water quality lawsuit, is removed from the suit in response to a motion by the sugar industry concerning his remarks to the press and potential bias.

The National Park Service receives a settlement of \$132,000 for the restoration of 2,691 square feet (250 sq m) of sea grass damaged by a vessel grounding near Crane Key in Everglades National Park, Florida.

The Continental Divide Research Learning Center inaugurates its year-round residential campus at the historic McGraw Ranch in Rocky Mountain National Park, Colorado (see page 22).

The National Park Service and the Republic of Gabon in western Africa sign a memorandum of understanding (MOU) recognizing their mutual interest in establishing and managing national parks and protected areas for the purpose of preservation, recreation, public education, and ecotourism. The National Park Service will provide technical assistance for park planning, general management and business plans, and possibly training in law enforcement, visitor services, and tourism. This MOU formalizes an opportunity for the National Park Service to assist in the preservation of the world's largest remaining tropical forest, which is five times larger than that of Costa Rica.

The report "Shoreline Trash: Studies at Padre Island National Seashore, 1989-1998" is released and documents the most extensive trash monitoring study of its type initiated in the United States. Results indicate that international regulations governing the dumping of plastics in the ocean have not reduced the amount of plastics that wash ashore at Padre Island National Seashore, Texas. The study also shows that the majority of the Padre Island trash originates from the Gulf of Mexico shrimp industry. Park staff have begun working with the shrimp industry to develop better technology, storage systems, and an education program to keep trash out of the Gulf of Mexico.

october

Judge Federico Moreno (Judge Hoeveler's replacement) appoints a Special Master, John Barkett, to help him oversee the settlement of the 1988 Everglades water quality lawsuit.

Canon U.S.A., Inc., announces selection of its 2003 National Parks Science Scholars: eight Ph.D. students studying in the United States, Argentina, Brazil, Canada, Mexico, and Peru.

The U.S. Animal Health Association approves the National Park Service as an official member, which is of particular importance because of the continued expansion of the park wildlife-livestock interface and potential for disease transmission.

november

The first wild-born California condor since 1984 fledges from its cliff nest at Grand Canyon National Park, Arizona (see page 83).

Staffs in Cuyahoga Valley National Park (Ohio), Catoctin Mountain Park (Maryland), and the Environmental Quality Division begin drafting an environmental impact statement for deer management that will serve as a template for other parks.

The U.S. Army Corps of Engineers fills a breach in the barrier island at Cape Hatteras National Seashore, North Carolina, caused by Hurricane Isabel, and transportation to Hatteras Village is restored (see page 78).

Managers of the Longview Power Plant, in West Virginia, agree to obtain additional emission allowances under the Acid Rain Program to offset its increase in actual emissions that would affect Shenandoah National Park, Virginia.

Associate Director Soukup issues final guidance to parks on implementing the directional drilling provision of the NPS nonfederal oil and gas regulations at 36 CFR 9B.

december

The State of Colorado files for in-stream flow protection of a reach of the Gunnison River that flows through Black Canyon of the Gunnison National Park, which will complete an obligation made by the Colorado Water Conservation Board in April.

Biologists release two captive-bred California condors from an acclimatization pen at Pinnacles National Monument, California (see page 84).

Cascade Dam, an obsolete hydroelectric power facility on the Merced River in Yosemite Valley, is demolished and removed from Yosemite National Park, California.

Transforming the National Park System

“Present-day management of nature in the parks differs substantially from that in the early decades of national park history—the most fundamental difference being the degree to which science now informs the Service’s natural resource practices.”

—Richard West Sellars
Preserving Nature in the National Parks: A History

Since its inception in 1999, the Natural Resource Challenge has garnered an approximate increase of \$76 million in base funding for natural resource management and research in the national parks. The Challenge is greatly helping to transform the Service into a modern and more effective bureau for the preservation of park natural resources. As reported in this chapter and throughout this publication, the Challenge has enabled NPS participation in Cooperative Ecosystem Studies Units and the establishment of monitoring networks, research learning centers, Exotic Plant Management Teams, and other important institutions. Together they are building knowledge of the parks, increasing the effectiveness of resource management strategies, engaging accomplished scientists in park research, and capturing the interest of the public in the requirements for long-term preservation of our national treasures. The articles reflect this exciting evolution and document positive trends in the care of the parks for the future.



National Park Service Director Fran Mainella cuts the symbolic “last” melaleuca tree in Big Cypress National Preserve, Florida, as forestry technician Billy Snyder looks on at a ceremony held February 4, 2003. Over a period of nearly 20 years the National Park Service and its partners battled the invasive plant species, treating approximately 14 million trees and bringing the species to a level that can now be maintained.

Nonnative melaleuca under control at Big Cypress National Preserve

By William A. Snyder, Antonio J. Pernas, and James N. Burch

IN 2003, BIG CYPRESS NATIONAL PRESERVE achieved a major victory in its 19-year battle with the exotic plant *Melaleuca quinquinervia* by completing the initial treatment of all known populations within the preserve. Melaleuca, a native of Australia, was introduced into Florida in 1906 as an ornamental. In the 1930s it was planted extensively to create forests in the swamps. It grows rapidly and produces dense monocultures that displace native plant communities and provide little food for wildlife.

On February 4, National Park Service Director Fran Mainella was on hand to cut the symbolic last melaleuca near preserve headquarters in Ochopee, Florida. “The National Park Service has been treating melaleuca since 1984 and has dealt with about 14 million stems at last count,” Mainella said. “We know this war will go on but we are marking a major victory in the initial effort to eradicate this difficult exotic species.”

Recognizing the need to join forces to stop the damaging impacts of melaleuca and other exotics, a group of resource managers in concert with land management agencies, research scientists, industry, and

“[Melaleuca] grows rapidly and produces dense monocultures that displace native plant communities and provide little food for wildlife.”

other interested groups formed the Florida Exotic Pest Plant Council (FLEPPC) in 1984. The council prioritized exotic pest plants in order to begin developing species-based management plans that incorporated tactical elements, priorities for funding, and strategies for tackling the broader issues of controlling these species. Those early efforts paved the way for an integrated pest management approach initiated in 1984 at Big Cypress and have resulted in the treatment of more than 14 million melaleucas at a cost of \$3.5 million.

In Big Cypress National Preserve, annual systematic reconnaissance flights revealed that melaleuca reached the height of its infestation in 1992. The tree species at varying densities occupied 186 square miles (482 sq km) of sensitive wetlands within the preserve. The main goal of treatment was not eradication, but rather bringing melaleuca to a maintenance level, a goal that has now been achieved. That is not to say there is no longer any melaleuca in the preserve. On the contrary, treatments and reconnaissance will continue in perpetuity, as seed sources occur throughout this part of Florida. Also, several problematic invasive plants still occur and have yet to be fully addressed. Brazilian pepper (*Schinus terebinthifolius*) occupies more than 1 million acres (405,000 ha) in southern Florida. And perhaps the most serious threat yet, Old World climbing fern, imported from Southeast Asia, is spreading unabated throughout the greater Everglades ecosystem.

exotic plant management

At the height of its infestation more than a decade ago, melaleuca stands infested some 186 square miles (482 sq km) of sensitive wetlands in Big Cypress National Preserve. An integrated pest management program involving many partners was critical to the success of reducing the invasive species to maintenance levels.



The control of melaleuca within Big Cypress National Preserve would not have been possible without a commitment from preserve management, FLEPPC, the Florida Department of Environmental Protection, South Florida Water Management District, Miami-Dade County, the U.S. Department of Agriculture, the Florida/Caribbean Exotic Plant Management Team, and many volunteers. This model of partnerships used in controlling melaleuca was transformational to Big Cypress National Preserve and shows that with commitment we can combat harmful invasive plants and continue to preserve our nation's natural heritage. ■

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Exotic Plant Management Teams: An update on the successful model in action

By Linda Drees

EXOTIC PLANTS INFEST approximately 2.6 million acres (1,052,220 ha) in the National Park System, reducing the natural diversity of these places. With funding from the Natural Resource Challenge, the National Park Service has established rapid-response Exotic Plant Management Teams (EPMTs) to control exotic plants. Modeled after wildland firefighting strike teams, EPMTs deploy highly trained, mobile forces of plant management specialists who assist parks in controlling exotic plants.

Each of the 16 EPMTs serves multiple parks within a broad geographic area. They work through steering committees to identify, develop, conduct, and evaluate the removal of exotic species, and undertake appropriate native species restoration efforts. Each team has developed site-specific strategies for combating exotic plants that reflect the needs and resources of the parks they serve.

“In 2003 seven ... new teams joined nine established teams, increasing the number of parks getting professional plant control to 219.”

The teams continued to make substantial progress in the control of harmful invasive plants on parklands in 2003. Seven teams were deployed during the summer. These new teams joined nine established teams, increasing the number of parks getting professional plant control to 219. In FY 2003 they inventoried exotic plants on more than 619,000 acres (250,695 ha), and found gross infestation of weeds on 518,898 acres (210,154 ha), which they treated. Since their inception in 2000, the teams have controlled at least 12 exotic plant species to a maintenance level.

The success of the EPMTs comes from their ability to adapt to local conditions and needs. Each team employs local experts and sets its own work priorities based on various factors: severity of threat to high-quality natural areas and rare species, extent of targeted infestation, probability of successful control and potential for restoration, opportunities for public involvement, and park commitment to follow-up monitoring and treatment.

Adaptive management is a critical part of the EPMT response. As the teams have grown, program managers have recognized the need for increased capability in setting priorities for control and restoration. As a result, the program, in conjunction with the Colorado Plateau Cooperative Ecosystem Studies Unit and the Intermountain Region restoration ecologist, is developing a tool, which will be available in two years, to set priorities for control. Additionally, in order to improve the assessment of technologies used for control, the team in southern Florida is collaborating with the NPS Environmental Quality Division and regional parks to develop a landscape-scale



Invasive plant species are difficult to control not only for their abundance in many national parks but also because of other challenges such as inaccessibility.

environmental impact statement for vegetation management. This is the first such effort for vegetation management in the National Park System and serves to streamline compliance actions. Parks in the Great Plains EPMT geographic area are conducting similar landscape-scale compliance.

Teams share operational information with private- and public-sector organizations, which have reviewed the NPS EPMT model with interest, studying and adopting aspects of the model. For example, in August 2003 at the Heinz Center workshop on invasive species databases, the fundamentals of the Alien Plant Control and Management Database (APCAM) were highlighted.

Through partnerships the National Park Service has leveraged more than \$2.8 million toward control of invasive plants. For example, collaboration with the University of Florida and the U.S. Department of Agriculture addresses impacts of invasive nonnative agricultural plants in natural areas of the U.S. Virgin Islands. A new program with



In 2003 the California Exotic Plant Management Team controlled pampas grass (*Cortaderia jubata*) growing on the Wildcat Cliffs of Point Reyes National Seashore, an effort that required climbing skills and careful attention to safety.

Natural Resource Challenge evaluated favorably by OMB

By Abigail Miller

The Natural Resource Challenge was one of the first government programs to be the subject of an Office of Management and Budget (OMB) requirement initiated in 2002. OMB's new Program Analysis Review Tool, or PART, was first applied to the Challenge in September 2002 for use in conjunction with development of the FY 2004 budget. The administration introduced this process to reform budget development by establishing a single tool for evaluating program performance and using the results as the basis for budgetary decisions. The PART score for 2002 was 72, considered very respectable. The process identified weaknesses in the NPS financial management system and the need for a comprehensive review of the Challenge by an objective party. A subsequent broadened review of the Natural Resource Stewardship and Science Directorate, which included the Natural Resource Challenge, was conducted in 2003 for the FY 2005 budget and resulted in an even higher draft score. Further information on PART and the 2002 evaluation is available from OMB's websites (<http://www.whitehouse.gov/omb/> [search on "PART"] and <http://www.whitehouse.omb/budget/fy2004/pma.html>). ■

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the Student Conservation Association uses "native plant corps," which will increase capabilities to control invasive plants and restore native species while training young professionals. In addition, through the Secretary of the Interior's Cooperative Conservation Initiative, several teams received grants to work with partners for invasive weed control to restore parklands.

It is a golden time for managing invasive species in national parks. Broad recognition from partners, visitors, and institutions indicates that invasive species are a major threat to our natural heritage. The increases in funding for invasive species management have certainly reflected this recognition and also demonstrated commitment. ■

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Environmental Quality Division's restoration program gains momentum

By Joe Carriero

LINDA CANZANELLI, superintendent at Biscayne National Park (Florida) for more than three years, has grown accustomed to vessel groundings at the National Park System's largest marine park. Canzanelli believes that the approximately 200 groundings reported each year represent only about 10% of the actual incidents on Biscayne's 165,000 submerged acres (66,825 ha). Unfortunately, most of the groundings occur on the park's vital seagrass habitat. "I think injuries to our seagrass beds will continue to increase," says Canzanelli. "As seagrass is stressed by natural changes and by human-created threats like pollution, sedimentation, and groundings, we are going to see a continual decline in this important ecosystem."

When motorized vessels run aground, propellers trench the bottom, uprooting seagrass, removing rhizomes, and displacing sediment. And when the grounded vessels attempt to power off, they often create deep blowholes. Such injuries are a concern because seagrasses at Biscayne (turtle grass—*Thalassia testudinum*—is the dominant species) provide many important benefits to the marine environment, including food and habitat for fish, invertebrates, birds, and endangered species like the West Indian manatee and several species of sea turtles.

A few years ago, resources injured at Biscayne and other parks would have been left to deteriorate. But now the National Park Service can use the Park System Resource Protection Act (16 U.S.C. 1911), passed in 1990, to pursue restoration to pre-injury conditions. Recently, Biscayne initiated seagrass restoration at three vessel grounding sites and Canzanelli is optimistic. She says, "My expectation is that the seagrass restoration projects will allow some of Biscayne's critical seagrass areas to survive."

An increasing number of restoration projects are now addressing injured resources across the National Park System. Parks are working with the Environmental Response, Damage Assessment, and Restoration (ERDAR) program office, part of the NPS Environmental Quality Division, to restore or replace critical wildlife habitat subjected to encroachments, vegetation fouled by oil spills, and seagrass beds and coral reefs injured by groundings.

Dan Hamson, chief of the ERDAR Branch, is enthused about the number of restoration projects now under way. He calls the Park System Resource Protection Act "a critical new tool for resource managers." "The 1911 statute lets us recover costs from parties who injure park resources," says Hamson. "This includes the cost of the immediate response to an incident, of the damage assessment, and of the restoration of the resources. If restoration is not feasible, we can recover the cost of replacing the resources or acquiring equivalent resources as compensation." Since the program began in 1993, the ERDAR Branch has helped settle dozens of cases, resulting in the collection of more than \$16 million for restoration or replacement of injured resources.

The branch includes experts who manage different phases of the complex restoration cases. The Damage Assessment Unit, headed by

ERDAR



Healthy turtle grass (above), the most common seagrass species at Biscayne National Park, contrasts dramatically with areas disturbed by powerboats. Legislation passed in 1990 enables the National Park Service, through its Environmental Response, Damage Assessment, and Restoration program, to recover costs for restoring the damaged marine habitat. Current projects at the park include restoring trenches (right) caused by motorboat propellers, and blowholes (below) created when stranded vessels "power off" shallows.



Rick Dawson in Atlanta, gets involved soon after the park's initial response to an incident. This unit appoints a case officer to help assess resource injuries, estimate the cost of restoration actions, and then work with a Department of the Interior solicitor and a Department of Justice attorney to develop and present the National Park Service's damage claim. Sometimes settlements are reached through litigation, but more often through negotiations with responsible parties.

During the assessment phase, ERDAR's Economic Support Unit, headed by Bruce Peacock, evaluates the ecological and human use services lost because of injuries to the resources. Peacock, an economist stationed in Ft. Collins, Colorado, determines the compensation value

George Dickison recognized for GIS contributions



The 2002 recipient of the Director's Award for Professional Excellence in Natural Resources is George Dickison, GIS and Information Resources Team Manager at the Alaska Support Office. As the leader of Alaska's GIS program, George had a vision to produce an integrated package of GIS

data, software tools, and data management procedures that would enable park staff to utilize GIS technology without requiring the assistance of GIS professionals, or as he puts it, "GIS in an other-duties-as-assigned atmosphere." Not only has he realized this vision for the Alaska parks, but also his team's software tools have become the National Park Service standard for the Inventory and Monitoring (I&M) Program and the fire management program.

When George joined the National Park Service 11 years ago, he assessed the GIS needs of the Alaska parks and refocused his team's efforts to meet those needs. He developed a creative approach for vegetation mapping that involved working with other agencies that had the same interests. Through partnerships with the I&M Program, FirePro Program, USGS EROS Alaska Field Office, Ducks Unlimited, the University of Alaska, and the National Wetlands Inventory, his team has completed more mapping in Alaska parks than has been accomplished in the rest of the National Park System combined.

The Alaska GIS team has won many awards, including the international ESRI Special Achievement Award as one of the outstanding GIS sites in the world. George and the GIS team have succeeded because they have built a program based on providing quality service to parks. According to George, "We have built a program, not a monument to a few talented individuals. Staff come and go. The measure of success is when you can survive staff turnover and continue to flourish with an ever-changing cast of characters. The Alaska program has done that. We have succeeded because we built a program based around quality service, a strong database focus, robust software development, and appropriate use of technology."

George was regional I&M coordinator for five years and his team now manages the Alaska I&M Program. He served on the national I&M steering committee, participating in the design of the program and contributing his much needed expertise to the huge challenge of developing data management strategies for the national program. He is active in natural resource management activities and also serves as chair of the Alaska Natural Resources Advisory Council. ■

of the lost resources either in dollars or in resource units such as acres of trees, square feet of sand beach, cubic meters of seagrass sediment, or numbers of organisms. The compensation value determined is added to the cost of primary restoration actions to make up the total restoration claim.

The final stages of the damage assessment and restoration process—restoration planning and implementation—have recently become more active. "More and more damage settlements are now being reached, and we are beginning to restore resources at more parks," says Tammy Whittington, manager of the Restoration Program Unit in Denver, which helps parks in planning and implementing restorations.

"The assessment and settlement phases are complex and time-consuming," says Whittington. "Settling a claim can take years. And then more planning is required before the actual physical restoration can occur. Most cases we get require not only a restoration plan but also National Environmental Policy Act compliance, public participation, and permits."

Nevertheless, Whittington and Hamson are encouraged by the number of new projects now in or entering the restoration phase. New initiatives include the restoration of tidal marshland at Golden Gate

"The ERDAR Branch has helped settle dozens of cases, resulting in the collection of more than \$16 million for restoration or replacement of injured resources."

National Recreation Area (California), breakwater restoration at San Juan National Historic Site (Puerto Rico), dune reconstruction and habitat enhancement at Padre Island National Seashore (Texas), and shoreline stabilization and dock replacement projects at the USS Arizona Memorial Visitor Center (Hawaii).

The ERDAR program is also helping parks promote collaborative restoration efforts. One example is an ongoing series of workshops with the National Oceanic and Atmospheric Administration focusing on ways to better coordinate and collaborate on coral reef and seagrass restorations. This partnership is especially appealing to Canzanelli, who says, "The enhanced restoration program will significantly benefit Biscayne's vital coral reef and seagrass habitats." ■

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Protection through connection: The Resource Stewardship and Protection Curriculum

By Jeri Hall

“Population growth and ... illegal activity threaten park resources as never before. Theft and marketing of artifacts, animal parts, plant life, and other illegal commercial activities threaten to bleed away the vital resource base of the parks.”

—The Law Enforcement Program Study Report (2000),
NPS response to the National Parks Omnibus Management Act of 1998

THE CHALLENGE OF PROTECTING the natural and cultural resources of the national parks is complex and requires coordination of a variety of important functions. These include applying a high level of resource knowledge to park management, educating the public about park resources and their protection, and professionally enforcing resource laws. One especially troubling concern is the vulnerability of park resources to theft and trade. In response to these needs the National Park Service has engineered an interdisciplinary, six-course training curriculum for the professional development of staffs to play a more effective, coordinated role in resource protection. Known as the Resource Stewardship and Protection Curriculum, the training emphasizes the proactive protection of resources by integrating park rangers, resource managers, interpreters, facility managers, and others. Ironically, specialized training of these staffs over the past couple of decades has isolated them from one another. The team approach, however, is stimulating collaboration among different park operations and regions and proving to be an effective strategy for the protection of highly threatened park resources.

The curriculum has been developed by teams of interdisciplinary NPS field employees in partnership with the Eppley Institute for Parks and Public Lands of Indiana University. Since its beginnings in Yosemite National Park in 1999, the curriculum has gained support from several NPS regions and at the national level. In FY 2002 and 2003 it was funded by the Natural Resource Protection Fund of the Natural Resource Challenge and the Pacific West Region, allowing for the curriculum's evaluation and refinement, and delivery to audiences throughout the National Park Service. This program is one example of how the Natural Resource Challenge has reached out not just to the scientists but also to the law enforcement and maintenance staffs of the National Park Service. Growing support for the training is indicative of an exciting transformation in the Park Service to a shared sense of responsibility for the welfare of park resources.

Four courses have evolved that reflect a philosophy of interdisciplinary collaboration for enhanced resource protection, while two courses target NPS employees who hold law enforcement commis-

sions. “Introduction to Resource Stewardship,” the first course, was attended by 25 employees this year, raising the total number of participants to more than 180. The third course, “Intermediate Resource Protection for Interdisciplinary Teams,” was designed in 2003 in conjunction with Indiana University and presented in December to 25 participants. “Resource Stewardship for Protection Rangers,” the second course in the series, was offered in 2003 in a revised format and attended by 26 law enforcement rangers, bringing the total number of participants to have completed it over the past four years to 110. Additionally, instructor and student notebooks for this course were finalized.

The curriculum's success has led to the potential for its implementation nationally. A draft report detailing options for this expansion was developed this year. Additionally, course coordinators developed a video describing the curriculum's mission and positive outcomes for use in promoting it. Finally, a cooperative agreement is in place with Indiana University to continue development and evaluation of the courses through 2005.



The protection of park resources is a shared responsibility, and a training program begun in Yosemite National Park is catching on across the National Park Service and institutionalizing this concept. The Resource Stewardship and Protection Curriculum emphasizes the development of interdisciplinary teams of highly trained rangers and resource and facility managers to meet today's complex resource protection needs in the parks.

This effort presents a long-term, strategic approach for the training of NPS employees in the use of law enforcement and resource protection techniques for natural and cultural resources. The course work is already giving these staffs the essential competencies to build proactive resource protection programs throughout the National Park Service. Interdisciplinary partnerships among natural and cultural resource employees, visitor and resource protection rangers, and other NPS personnel are enhancing the application of field-based techniques to protect park resources. ■

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Great Lakes Research and Education Center celebrates successful first year

By Joy Marburger and Wendy Smith

IN ITS FIRST FULL YEAR of operation the Great Lakes Research and Education Center (GLREC), located at Indiana Dunes National Lakeshore, made tremendous progress toward its goals of facilitating outstanding research and education opportunities for its network parks. Research learning centers like this one are a key component of the Natural Resource Challenge because they involve a wide spectrum of Americans in opportunities to better understand our natural world and facilitate collaborative research efforts that benefit the parks. With this in mind the GLREC launched an array of research and education projects in 2003.

As with any new enterprise, much of the first year was spent making people aware of the center's services and potential. Joy Marburger, GLREC research coordinator, and Wendy Smith,

“Learning centers ... involve a wide spectrum of Americans in opportunities to better understand our natural world and facilitate collaborative research efforts that benefit the parks.”

GLREC education coordinator, began early on to network with researchers, managers, educators, and the public to promote natural resource research that addresses broad management issues in the Great Lakes Network parks. All the hard work resulted in a number of collaborative activities that use current research and are designed to benefit the parks.

Two research projects were established in 2003 at Indiana Dunes, Pictured Rocks, and Sleeping Bear Dunes National Lakeshores. The projects involved collaboration with other organizations and agencies. For example, researchers from the U.S. Geological Survey (USGS) and the Chicago Botanic Garden conducted research on the population genetics of Pitcher's thistle (*Cirsium pitcheri*), a federally threatened species. Another project explored the population genetics of marram beach grass (*Ammophila breviligulata*) and associated soil fungi, which was conducted by Chicago Botanic Garden and Cornell University researchers. Both projects will help park managers develop better freshwater beach restoration methods.

Collaborative research efforts are of clear value to national park managers. “The Great Lakes Research and Education Center's role in facilitating multi-park research projects definitely provides wider avenues for researchers to address national park management issues in a variety of disciplines,” according to Indiana Dunes National Lakeshore superintendent Dale Engquist.

The highlight of outreach activities involving multiple parks was a successful two-day purple loosestrife workshop held in Spooner,

research learning centers



Above right: Participants at an August 2003 workshop hosted by Great Lakes Research and Education Center learn hands-on survey and control methods for purple loosestrife, a nonnative plant, from USGS researcher Beth Middleton (top left). Controlling purple loosestrife is of special concern because it is highly invasive and forms dense stands that restrict native wetland plants and reduce habitat for waterfowl.

Bottom left: Robin Goettel, Illinois-Indiana Sea Grant communications coordinator, demonstrates a purple loosestrife invasion in a model wetland. Participants drew representative wetland plants and animals on paper, and purple confetti, representing dispersing seeds, was blown across the wetland with a fan.

Wisconsin, in late August 2003. Purple loosestrife (*Lythrum salicaria*) is a highly invasive, nonnative plant that forms dense stands that restrict native wetland plants and reduce habitat for waterfowl. The workshop was designed to foster interagency partnerships with Great Lakes national parks to integrate research information with hands-on survey and control methods, and to provide education and outreach tools to teachers and volunteers.

“Two research projects were established in 2003 at Indiana Dunes, Pictured Rocks, and Sleeping Bear Dunes National Lakeshores.”

Speakers represented a wide range of agencies and organizations and presented information from the perspectives of federal, state, and local concerns. Workshop participants also represented a broad range of stakeholders, including resource managers, interpreters, educators, researchers from nonprofit organizations, businesses, and concerned citizens. Many of the participants enthusiastically volunteered to assist with a USGS purple loosestrife monitoring project and Wisconsin’s biological control program. Workshop evaluations showed that people appreciated the interaction of speakers and participants from diverse areas, the flow of ideas among groups, the exploration of communication issues on purple loosestrife control,

and the opportunity to become involved in hands-on scientific research. The workshop was rated excellent or above average by 92% of the participants.

From facilitating research projects to hosting the purple loosestrife workshop, the GLREC has begun to fulfill its role as a field station for collaborative research and educational activities. In the years ahead it will continue to attract researchers to address a multitude of management issues facing Great Lakes parks and assist with development of related educational outreach programs. ■

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NPSFACT

Funding for natural resource management and research in the national parks more than doubled over the last 10 years, **from \$87.0 million in FY 1994 to \$191.0 million in FY 2003**. This dramatic increase includes \$67.4 million as a result of the Natural Resource Challenge. As a percentage of the budget for the operation of the National Park System (ONPS), natural resource management and research funding rose from **10.4% to 12.2%** over this period.

From guests to researchers: The adaptive reuse of McGraw Ranch

By Judy Visty

Research learning centers of the National Park Service combine the elements of field stations, partnerships, active support of research, and information transfer to fulfill the mandate of the Natural Resource Challenge. In September 2003, the Continental Divide Research Learning Center inaugurated its year-round residential campus located at the historic McGraw Ranch (photo) in Rocky Mountain National Park (Colorado).

A main focus of the research learning centers is to reuse existing facilities to provide expanded bed, office, and lab space for scientists and educators. In 1988, when the park acquired the McGraw Ranch property, it intended to raze the buildings and restore the land to elk and bighorn sheep habitat. A new superintendent at the time, Randy Jones, and a statewide outcry from preservationists led to a partnership with the National Trust for Historic Preservation. Fee demonstration funds, Colorado’s State Historical Fund, and donations



Visiting researchers to Rocky Mountain National Park are now able to bunk, prepare food, and use office facilities at the refurbished McGraw Ranch, the residential campus of the Continental Divide Research Learning Center.

from the National Trust, Rocky Mountain National Park Associates, and private individuals paid for the \$2 million project, which was completed in 2003.

Adding bunk beds may seem like an odd way to instigate government reform, but beds for visiting researchers are a key to ensuring their willingness and ability to come to parks to

do research. Most visiting researchers cannot afford the high temporary housing costs found near many national parks. And camping in a tent for several weeks may sound romantic but has limitations when fieldwork involves long hours, bad weather, and strenuous physical activity. A room with shared kitchen facilities allows a researcher to have a dry place to write up notes, eat, and get a good night’s sleep before going out and doing it all over again. The “field station” environment at McGraw Ranch also fosters information exchange with other scientists and park staff.

Further information on the Continental Divide Research Learning Center is available on the Web at <http://www.nps.gov/romo/education/CDRLC/index.html> or from the author (judy_visty@nps.gov, 970-586-1302). ■

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Examining Dyke Marsh restoration options: A teacher-scientist partnership in the National Capital Region

By Cathlyn Stylinski, Ph.D.

IT IS HOT AND HUMID at Dyke Marsh, the largest freshwater tidal wetland in metropolitan Washington, D.C., and a part of the George Washington Memorial Parkway, Virginia. A four-person research team slogs through the sucking mud and dense, tangled stands of cattails, impatiens, and morning glories. Their goal? To lay out a long transect and record plant species in several 1-meter plots. They locate each plot with a GPS unit and push short PVC tubes into the ground to collect samples of seeds stored in the black ooze. The research team is surveying the vegetation to examine restoration options for the marsh, which has been diminished by dredging and eroded shorelines.



Teacher fellow Darren Wilburn consults with researcher Steve Seagle on the identity of a wetland plant. Together with another teacher fellow (Mike Allred) and researcher (Katia Engelhardt), they are inventorying plants and seeds. The data they collect will help researchers develop a restoration plan for the marsh.

The group works well together, which might seem ordinary but for the fact that this is not a typical research team. Drs. Katia Engelhardt and Steven Seagle are seasoned scientists from the University of Maryland Center for Environmental Science–Appalachian Laboratory. Rounding out the team are two secondary school teachers from Maryland, who just a few weeks earlier did not know a spatterdock from an arrow arum and never considered that the seed bank is part of the vegetation community. What brought them together was an outreach program funded by the Urban Ecology Research Learning Alliance, the learning center of the NPS National Capital Region. Teacher fellows spend their summer working beside researchers and developing related classroom extensions of their experience. The program provides valuable support to NPS resource management projects while deepening the teachers' understanding of science research and critical natural resources like Dyke Marsh.

"I have a better understanding of how scientists do their job," says Mike Allred, a high school science teacher. "I learned that an incredible amount of work has to be done before setting foot in the field." Middle

school teacher Darren Wilburn adds, "I always thought of researchers as professors in white coats who had all the answers. But now I see that they're always learning and that they may not know the answers, but they know how to search for them."

"I've never worked with such highly motivated people," says Dr. Engelhardt. "The teachers quickly picked up on the project's goals and tasks and brought in their own creativity. It's truly a collaborative effort." Dr. Seagle agrees. "We couldn't have gathered as much data without their help."

With these data, the team is mapping the distribution of plant species at Dyke Marsh and exploring the effect of elevation and distance to tidal creeks on vegetation communities and seeds stored in the soil. This critical information will help determine whether marsh restoration efforts require intensive planting or if native plants will naturally recolonize from the seed bank.

Despite the oppressive summer conditions and scathing rice-cutgrass, the team is enthusiastic and excited about their work. "Dyke Marsh is such a valuable resource," says Mr. Allred. "It's so close to D.C., but lots of people don't know it exists." "Many people have a misconception that it's a mosquito breeding ground, so we should get rid of it," notes Mr. Wilburn. "But it's beautiful and so lush."

As part of their fellowship, the teachers are developing inquiry-based classroom applications that build on their National Park Service research experience. In Mr. Allred's classroom activity, students experiment with different factors that limit growth of hydrilla, an exotic, submerged plant that is invading many wetlands, including parts of Dyke Marsh. Mr. Wilburn is applying his new expertise in wetland ecology to bogs and fens in western Maryland. His students will use some of the same sampling techniques he learned at Dyke Marsh.

These teachers will also share their experience and activities with other educators online, in informal discussions, and at regional conferences. This successful outreach program of the Urban Ecology Research Learning Alliance and the University of Maryland Center for Environmental Science–Appalachian Laboratory will continue in summer 2004 with new teacher participants. ■

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Former naval base home to new research learning center at Acadia National Park

By John T. Kelly



A former navy base, the research learning center facilities at Acadia National Park are in the process of being converted to bunk, classroom, lodging, and lab space for visiting researchers and educators. In 2003 the center hosted more than a dozen researchers and conducted 13 residential education camps for more than 460 fifth through seventh grade students.

The timing of the Natural Resource Challenge and creation of NPS research learning centers was especially opportune for Acadia National Park, Maine. About the time that Acadia received approval for its research learning center, the U.S. Navy was preparing to close a base located within the Schoodic Peninsula section of the park. In 2002, the navy transferred the 100-acre (40-ha) base to the National Park Service. The former base is now home to the Schoodic Education and Research Center.

Acadia National Park is overcoming the challenge of converting more than 35 buildings from military to research and education use. The park is working with partners, such as the University of Maine, to create a niche for research and education that is unmatched in the region. The goal of the Schoodic Education and Research Center is to provide research and education benefits beyond the boundaries of the park. To meet this vision the center will facilitate education and research to promote the understanding, protection, and conservation of natural and cultural resources of the National Park System. It will also advance related research at the regional, national, and international levels.

In 2003, park managers began a strategy to attract partners to the research learning center and prepared a business plan that includes a market and economic viability analysis of the site. The park is also establishing an independent nonprofit organization to assist with the center's development and operation. The nonprofit will coordinate partners and manage center activities, while the park provides facility management and security for the campus. The park will expand the operation of Schoodic Education and Research Center with demonstration projects and other program activities in 2004. ■

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Landmark year for Cooperative Ecosystem Studies Units

By Jean E. McKendry and Gary E. Machlis

THE COOPERATIVE ECOSYSTEM STUDIES UNITS (CESUs) Network provides research, technical assistance, and education to federal resource management, environmental, and research agencies, and their partners. Each CESU is a collaboration of federal agencies, a host university, and partner institutions. Since June 1999, when the first four CESUs were established, the network has grown considerably.

By contemporary standards, the network is young and emerging. Yet, much has been accomplished between 1999 and 2003: 16 CESUs were competitively established and became operational, with the 17th (and final) CESU nearly completed (see map). Thirteen federal agencies from five departments—Interior, Agriculture, Commerce, Defense, and Energy—participate in the network. The 16 CESUs include 120 universities and colleges (25 participate in more than one CESU), and 22 of these universities and colleges are minority institutions: Historically Black Colleges and Universities, Native American Tribal Colleges, and Predominantly Hispanic Serving Institutions. The other 34 CESU partners range from Audubon of Florida and the American Indian Science and Engineering Society to the Missouri Botanical Garden and the Alaska Department of Fish and Game.

As the number of CESUs in the network has grown, so have the number and range of projects. By December 2001 and the close of the first inventory, 500 projects were catalogued as under way or completed; that number is now well over 1,000. Network projects range from small monitoring projects to a million-dollar restoration effort, incorporating expertise from the biological, physical, social, and cultural sciences, and many fields of cultural studies and the humanities.

In June 2003 the CESU Network held its Third Biennial National Meeting in Washington, D.C. More than 150 representatives from federal agencies, universities, and other partners across the country and across the CESU Network participated. The meeting included

"The National Park Service has been very active in the CESU network, contributing to its growth and maturation."

profiles of CESU projects and sessions on implementing CESUs, funding opportunities, and federal agency opportunities and needs. Most importantly, the meeting provided a chance for participants from newer CESUs to learn from the more experienced CESUs.

In addition to the growth of the CESU Network, much activity is related to maturation of individual CESUs. For example, almost every CESU has added partners (33 in all). Several CESUs have begun to hold joint meetings and share functions with one another. Contracting officials from participating federal agencies and universities have gained experience and applied their skills to moving projects forward. The first

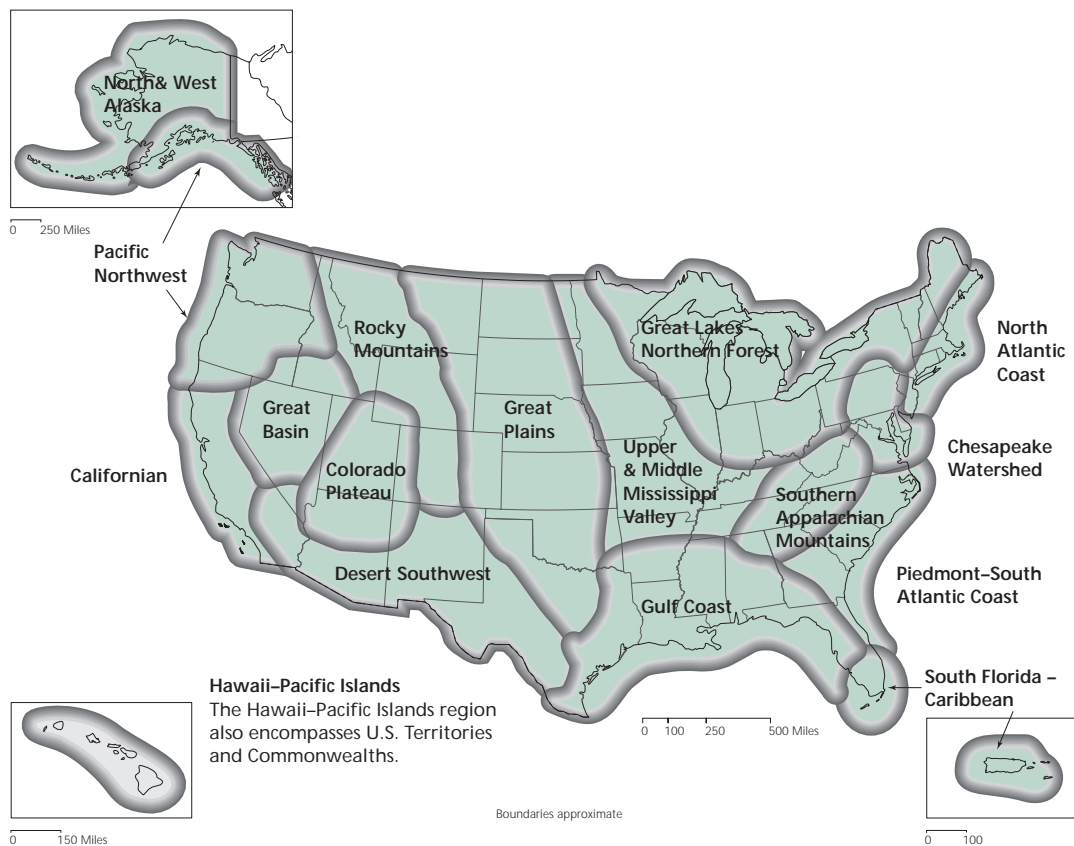
COOPERATIVE ECOSYSTEM STUDIES UNITS NETWORK

Sixteen Cooperative Ecosystem Studies Units were in operation in 2003, with the 17th and final CESU to be initiated in 2004 in Hawaii and the Pacific Islands.

- In the CESU Network
- Being established in FY 2004

Participating Federal Agencies:

Bureau of Land Management
Bureau of Reclamation
US Fish and Wildlife Service
US Geological Survey
National Park Service
Agricultural Research Service
USDA Forest Service
Natural Resources Conservation Service
National Marine Fisheries Service
Department of Defense
Department of Energy
Environmental Protection Agency
National Aeronautics and Space Administration



four CESUs will be up for renewal in 2004, and the CESU Council has established a renewal process that is both efficient and substantive, including self-assessment, independent review, minimal paperwork, and maximum confidence that CESUs operating effectively should be renewed.

A long-term strategy is also critical to the CESU Network. In spring 2003, after considerable input from federal agencies and a public comment period, the CESU Council released the CESU Network Strategic Plan for FY 2004–2008. This plan includes several important network initiatives, from advancing the information infrastructure of CESUs to encouraging multiagency, transboundary projects.

The National Park Service has been very active in the CESU Network, contributing to its growth and maturation. As part of the Natural Resource Challenge, the National Park Service placed coordinators at the host university for each of 12 CESUs, serving as “brokers”

to match park needs with university expertise and facilitate interagency collaboration. The Challenge also has provided funding for NPS projects at CESUs.

Cooperative Ecosystem Studies Units provide opportunities to create sound science and scholarship, give skillful public service, and deliver usable knowledge to federal agencies and their partners grappling with the environmental challenges of the 21st century. The first four years in the development of the network are evidence that these challenges can be overcome through the CESU Network as it continues to grow and mature. ■

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The New Face of Professional Resource Management

*“Employees of the
National Park Service
are our best asset.”*

—Fran Mainella
NPS Director

Natural resource management in the national parks has a human face and it has changed. For more than a decade, NPS managers have recognized the increasing complexity of management issues affecting parks and the corresponding level of human effort and expertise necessary to preserve parks for the future. The response has been a gradual but consistent increase in the number and professional training of resource managers in the workforce. Since 1999 the Natural Resource Challenge has highlighted the need for professional positions to deal with a wide variety of technical issues related to water and air resources across the park system. With few parks able to hire their own specialists, new positions are being strategically located to serve multiple parks where the needs are greatest. Five of these new air and water resources staff are profiled in this chapter, their accomplishments related chiefly to technical assistance in their geographic focus areas, and the identification of research needs. The Challenge has also pointed to the need for highly trained individuals to design effective resource monitoring strategies, a critical function for the future of the parks. These doctorate- and master's-level natural resource experts, four of whom are profiled here, contribute valuable energy, intelligence, and experience to the fledgling monitoring networks. Altogether these staff are part of a new critical mass of expert natural resource managers in the National Park Service. They are extending the bounds of what we in the National Park Service can accomplish, what we must accomplish, to ensure the continuing enjoyment of park natural resources by the American people.

Brenda Moraska Lafrancois, Ph.D.

Great Lakes Area Aquatic Ecologist



Brenda Moraska Lafrancois had just completed her dissertation work in ecology and fishery and wildlife biology when she joined the National Park Service as an aquatic ecologist in September 2002. Her position, funded under the Natural Resource Challenge, was developed to provide aquatics expertise for the

many water-rich parks of the Great Lakes area. Over the past year, meeting this objective has taken a variety of forms. She has analyzed long-term water quality data for St. Croix National Scenic Riverway (Wisconsin and Minnesota), helped prepare a water resource management plan for Isle Royale National Park (Michigan), and provided assistance and oversight for research projects at Isle Royale, Sleeping Bear Dunes National Lakeshore (Michigan), and Voyageurs National Park (Minnesota). With Jay Glase, a fisheries biologist hired simultaneously for the same set of parks, Brenda is preparing reports that synthesize aquatic research across Great Lakes parks and working

with the Great Lakes Inventory and Monitoring Network to make the reports useful to all the network parks.

As a child in Wisconsin, Brenda spent a lot of time on a river that became increasingly polluted as she was growing up, sparking her interest in water quality. In the summers, on family vacations in the West and Southwest, she always enjoyed visiting national parks. When this position was created—aquatic ecologist in the national parks in her native Midwest—it seemed like the perfect fit for her.

Brenda appreciates the broad perspective her position offers. “I have enjoyed working in this regional context and getting to know a diverse group of aquatic resources and people. Best of all, I like applying my skills to interesting aquatic resource questions and contributing to scientific understanding at a terrific set of parks.” ■

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NPS staff since September 2002

St. Croix Watershed Research Station, NPS Water Resources Division;
Marine on St. Croix, Minnesota

PROFESSIONAL PROFILES

water resources

James M. Long, Ph.D.

Fishery Biologist



The Southeast Region is an area with some of the highest biological diversity of aquatic organisms, particularly fish. Therefore, the National Park Service, through the Natural Resource Challenge, created a regional fisheries biologist position. The first specialist to fill that position is Jim Long, and with 64 parks in this region situated in freshwater and marine environments, there is never a shortage of fish-related issues to keep him busy. In 2003, Jim was working on shoal bass restoration at Chattahoochee River National

Recreation Area (Georgia), assisting Biscayne National Park (Florida) with their developing fisheries management plan, and working with staff and partners of Congaree Swamp National Monument (South Carolina) toward understanding the role of flooding on fish communities and the impacts from reduced flooding due to the operation of an upstream hydroelectric dam.

Jim received his doctorate in wildlife and fisheries ecology from Oklahoma State University in 2000, working on community ecology of black bass in reservoirs. Afterwards, he worked as a research fisheries biologist with the South Carolina Department

of Natural Resources examining interrelationships between fish communities and physical habitat in wetlands of the Cooper River. Jim brings training and interests in fisheries management, population and community ecology, and statistical methodology to help manage aquatic biodiversity in the parks of the Southeast Region.

With the skills of scientists like Jim Long, we are increasing our understanding and ability to manage these important aquatic environments. “I look forward to meeting these challenges,” Jim says, “addressing known fisheries-related issues, and bringing my expertise to the parks to identify unknown issues.” ■

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NPS staff since August 2002

Southeast Region, NPS Water Resources Division;
Atlanta, Georgia

Alan C. Ellsworth, M.S.

Northeast Regional Hydrologist



As the new Northeast Region hydrologist, Alan Ellsworth is the principal point of contact for water-related issues, serving as liaison for the Washington Office, Water Resources Division. In this capacity he provides support for study planning and design, reviews resource impact plans, assists with funding proposals, and provides inter- and intra-agency contact assistance.

What Alan likes about his job is that “it allows me to be involved with a diverse array of water resource issues across a large region that was home to me until I was 25 years old. I interact with natural resource professionals from a variety of backgrounds and have been able to expand my knowledge and interests through the projects and support the National Park Service has provided me.”

Indeed, he is currently involved in a wide variety of water resource issues in geographically and hydrologically diverse settings. Locally, he has worked with Delaware Water Gap National Recreation Area and Upper Delaware Scenic and Recreational River (Pennsylvania, New York, and New Jersey) on such issues as habitat flow needs (with a multiagency project), special protection water quality regulations, groundwater monitoring, and Federal Energy Regulatory Commission relicensing.

Across the region he has been involved in a natural resource review for the general management plan of George Washington Birthplace National Monument (Virginia), overseen a stream sediment sampling project at Valley Forge National Historical Park (Pennsylvania), conducted field surveys and project evaluation for wetlands restoration at Minuteman National Historical Park (Massachusetts), and consulted with other agencies to establish stream impairment sampling protocols for Shenandoah National Park (Virginia).

Before accepting this appointment he worked in the western states for eight years at the USDA Forest Service Rocky Mountain Research Station as a physical scientist studying the effects of atmospheric deposition on alpine and subalpine watersheds. Returning to the Northeast for his new position, he says that although the larger parks of this region are spectacular, he has been most impressed by the natural resource protection afforded by small cultural parks in this largely urbanized corridor. ■

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NPS staff since October 2002

NPS Water Resources Division; Delaware Water Gap National Recreation Area, Pennsylvania

PROFESSIONAL PROFILES

water resources



Buford Dam marks the upstream boundary of Chattahoochee River National Recreation Area, Georgia. The dam discharges water from the bottom of the reservoir, depressing water temperature in the Chattahoochee River, and has resulted in the elimination of many native fish species from the park. Fishery Biologist Jim Long takes part in water quantity negotiations among three states that will dictate new flow regimes from the dam. He ensures that park fishery issues are adequately considered during the negotiations. Hydrologist Alan Ellsworth and Aquatic Ecologist Brenda Moraska Lafrancois are also involved in lake level and river regulation issues in national parks of the Northeast and Great Lakes, respectively. Their efforts are focused on monitoring the ecological effects of regulated river flows and lake levels on park resources and enhancing aquatic habitat.

Elizabeth Waddell

Air Resources Specialist



Elizabeth Waddell brings 25 years of experience in the atmospheric science community to her newly created position in the NPS Air Resources Division. Her previous work with the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration and her many contacts with state air quality agencies have already enabled

her, during her first year on the job, to build partnerships and to enhance the role of the National Park Service with state and federal regulators. As a result, the National Park Service now has a stronger presence on a number of technical and policy forums in the Northwest, including the Northwest International Air Quality Environmental Science and Technology Center and EPA Region 10's Office of Air Quality Leadership Team. Partnering has already benefited one park in particular: Elizabeth was able to obtain substantial funding to provide ultra-low-sulfur diesel fuel and to retrofit diesel equipment at Mount Rainier National Park (Washington) with catalysts or filters to reduce air pollution.

Elizabeth has long been interested in working with air resources in the National Park Service. As she tells it, "Over a decade ago, I met the air resources coordinator for the Pacific Northwest Region of the Park Service, Shirley Clark. At the time, I was working for EPA providing support for air toxics research and regulatory development by the state air agencies in the Northwest. As we talked, I learned about Shirley's role in evaluating and promoting research into air quality impacts on the parks, as well as her regulatory role under the Clean Air Act as a federal land manager. I concluded that she had the best job in the world. I am amazed and thrilled that, through funding from the Natural Resource Challenge, I now have that job! I am looking forward to continuing to build partnerships that will enhance our ability to evaluate and address air quality impacts on our national parks." ■

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NPS staff since December 2002

Pacific West Region; Seattle, Washington

PROFESSIONAL PROFILES air resources

Michael George, M.S.

Texas and Border Region Air Quality Coordinator



Having worked in both the public and private sectors, Michael George brings 13 years of experience in air quality to the National Park Service. From his office in Austin, he now applies his expertise on behalf of 15 national parks in Texas and along the Mexican border. Before joining the National Park Service in 2003, Michael worked in the Air Quality

Division at the Arizona Department of Environmental Quality. In that position he managed technical programs that performed air quality monitoring and modeling and developed inventories of pollutant emissions.

His current air resources responsibilities encompass a broad range of technical and policy issues that make use of that experience. An example is his work with the Central States Regional Air Partnership, an organization of states and tribes that covers the central United States, stretching from Canada to Mexico, and assists its members in meeting the visibility requirements of the Clean Air Act. Michael's work with this organization helps to ensure that air quality planning in the region appropriately protects Class I area parks (the larger parks that are given additional air quality

"I always enjoyed working with the Park Service people, so I looked forward to doing that full-time in this new position. I couldn't ask for a better opportunity."

protection by the Clean Air Act). His participation in local air quality planning and technical activities is providing the parks with a more direct voice than has been the case in the past.

Michael has participated in a number of projects through the years in which the National Park Service has been a partner, and says, "I always enjoyed working with the Park Service people, so I looked forward to doing that full-time in this new position. I couldn't ask for a better opportunity." ■

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NPS staff since March 2003

Center for Energy and Environmental Resources, University of Texas; Austin, Texas

Bruce Bingham, M.S.

Intermountain Regional Inventory and Monitoring Coordinator



Bruce Bingham comes to his new position from the USDA Forest Service where he was assistant program manager for the Interagency Regional Monitoring Program, associated with the Northwest Forest Plan. Working with eight federal agencies, Bruce coordinated several activities for the program, which monitors the northern spotted owl, the marbled murrelet, the amount and distribution of old-growth forests, watershed condition, and other indicators of the health of the Pacific Northwest forests. This experience prepared him for his current job of developing monitoring programs for the National Park Service.

Earlier in his career, when Bruce did research as a vegetation ecologist for the USDA Forest Service, Pacific Southwest Research Station, he worked under Dr. Barry Noon, who was involved in conceptual modeling for the NPS prototype monitoring programs. Bruce has also worked for The Nature Conservancy managing three preserves. All of his previous work has been in the Pacific

"I'm really excited to be working here because of my strong belief in the mission of the National Park Service."

Northwest, but he expects that the move to the new region will not be a problem. "The Intermountain Region is huge and contains lots of diversity, like the Pacific Northwest. Although many of the ecosystems are different from those of the Northwest, learning to understand systems and monitoring them are similar challenges in every region."

Bruce had just taken his new post at the time of this writing. He says he is looking forward to his role as I&M coordinator. "I'm really excited to be working here because of my strong belief in the mission of the National Park Service." ■

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NPS staff since October 2003
Denver, Colorado

PROFESSIONAL PROFILES

resource monitoring

John E. Gross, Ph.D.

Ecologist



Selecting ecological vital signs, the species and other factors that reflect the integrity of an ecosystem, is a formidable challenge. Meeting this challenge requires scientists with the broad expertise to understand whole systems and the interactions of their parts. John Gross has this expertise. Hired through the Natural Resource Challenge as an ecologist, his job is to provide scientific support to Inventory and Monitoring Networks throughout the National Park Service as they develop their monitoring programs, and to coordinate scientific activities across the networks. One of his tasks is to see the big picture: how the larger landscapes in which parks are embedded influence their resources, and how the many parts of the system are connected. Monitoring networks need this information to identify candidate vital signs that will effectively support decisions on management of park resources.

John has a strong background in quantitative ecology and systems modeling, which has sharpened his ability to think holistically about ecosystems—considering all the parts and how they fit together. "That's what excites me, and that's what the Inventory and Monitoring Program is all about," he says.

His early research focused on behavior and ecology of large mammals, including studies of native goats (ibex) in the deserts of Israel and Pakistan and in the Swiss Alps. In the United States, he has studied ecosystem ecology in western national parks and elsewhere. Before coming to the National Park Service, John was a landscape ecologist in Australia studying tropical savannas in the extensive outback of northern Australia and the sustainability of small, yet complex, household farming systems in Indonesia. In those studies, he used a highly integrative systems approach to understand how environmental and social factors influence ecosystem sustainability. When it comes to learning about ecosystems and human influences on them, John says, "I'm like a kid in a candy store. It all looks good to me. I'm interested in all sorts of stuff." ■

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NPS staff since June 2003
Inventory and Monitoring Program, Natural Resource Information Division;
Fort Collins, Colorado

Greg Shriver, Ph.D.

Northeast Temperate Monitoring Network, Inventory and Monitoring Coordinator



Greg Shriver's success in partnering for grassland bird monitoring data was a big factor in his selection as the Northeast Temperate Network inventory and monitoring coordinator, says regional I&M coordinator Beth Johnson. Greg has a great deal of experience in both partnering and monitoring. For his doctorate in conservation biology, he sur-

veyed 235 salt marshes from eastern Maine to southern Connecticut. During that study and his work for the Massachusetts Audubon Society, Greg surveyed more than 1,300 sites for grassland and saltmarsh breeding birds. As a postdoctoral research fellow at the National Estuarine Research Reserve in Wells, Maine, he worked to implement a Gulf of Maine-wide saltmarsh restoration monitoring program designed to determine the effects of restoration projects on the physical environment and the flora and fauna. These monitoring

experiences demonstrated to him the importance of working with other agencies and of integrating regional survey protocols.

Through the Natural Resource Challenge's long-term support, Greg says, the National Park Service can do monitoring long enough to reveal trends that provide real insight into what's happening in the environment. "This is a big job and we need all the help we can get from other agencies that are interested in this information. We need to build on existing programs and design monitoring protocols that are compatible with those already in use. Partnering, we can take advantage of available expertise, and by publicizing the work that's being done in the field we can interest nonexperts, such as students, who can assist in collecting data. Furthermore, we can encourage the support of the public by sharing and interpreting—in articles, brochures, and presentations—understanding of our natural resources resulting from the monitoring effort." ■

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NPS staff since December 2002

Northeast Temperate Monitoring Network, Marsh-Billings-Rockefeller National Historical Park; Woodstock, Vermont

PROFESSIONAL PROFILES

resource monitoring

Diane Sanzone, Ph.D.

Arctic Network Inventory and Monitoring Coordinator



Diane Sanzone's job requires her to do species inventories and develop a long-term monitoring program in the five parks in the Arctic Network. Her job presents a huge challenge: these parks occupy more than 21 million acres (8.5 million ha), or roughly 25% of National Park System land, and though they are pristine and magnificent, they are frigid and dark much of the year, requiring her to do most of her

fieldwork during the short summer season. Even then, getting into the field is not easy, she explains. "These parks are probably the most remote parks in the United States. It takes days just to get to some of our field sites. There are no roads, so we use float planes and helicopters and river travel to get to field sites. Getting in or out of a site can take days because of poor weather conditions."

These difficulties have not dampened her enthusiasm, even though she was pregnant while flying and sailing over this rough terrain during her first summer in her new job. She finds these Arctic parks "some of the most beautiful places on earth! Most of the time when we are flying over the parks my mouth is agape and all I can think about is how lucky I am to be experiencing such rugged and wild wilderness."

Diane grew up in New Jersey and went to graduate school at the University of Georgia. She spent a year in Iceland as a Fulbright Scholar studying nitrogen dynamics in Arctic streams. Then, before joining the National Park Service, she was a postdoctoral scientist at the Marine Biological Laboratory in Woods Hole, Massachusetts, where she studied ecosystems of the rivers in the Arctic National Wildlife Refuge in Alaska. She is joined in Alaska by her husband, who works at the Toolik National Science Foundation Long-Term Ecological Research site. Their baby, Madeleine Isabella, is due in January 2004. ■

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NPS staff since June 2003

Gates of the Arctic National Park and Preserve; Fairbanks, Alaska

Professional natural resource management staff numbers up over last decade

By Abigail Miller

THE ROSTER of professional natural resource management staff in the National Park Service is growing steadily, according to an analysis of personnel data conducted in 2003. For this analysis, professional resource managers are those whose positions are officially classified by the Office of Personnel Management (OPM) as professional (not technician-level) biologists, physical scientists, mining engineers, and geographers. Of the 272 national parks deemed to have significant natural resources, approximately 70% (192) had at least one professional-level resource manager on staff in 2003, compared to about 50% (134) 10 years ago. In 2003, 77% of those staff were stationed in parks or field-based support units (such as inventory and monitoring networks), compared to two-thirds in 1993. About 80% of the positions occupied by these staff are in biological disciplines, with a small increase in the percentage of specialized biologists. Additionally, the percentage of park biologists having advanced degrees upon entering the National Park Service increased slightly between 2000 and 2003.

“The number of professional resource managers in the National Park Service has more than doubled, from 487 in 1993 to 1,049 in 2003.”

Similar analyses in 1993, 1997, and 2000 round out the picture of professional natural resource staffing trends over the last decade. The first year, 1993, reflects the loss of approximately 200 NPS researchers and related support staff to a reorganization. By 1997 the natural resource ranks had rebounded, almost certainly from budget initiatives in fiscal years 1994 and 1995 aimed at increasing natural resource professionals in the parks. The staffing increases in 2003 undoubtedly reflect gains made through the Natural Resource Challenge. However, little Challenge-related growth would have been reflected in the (February) 2000 totals, only five months into the first year of this initiative. Therefore, the staffing increase between 1997 and 2000 may demonstrate a steadily growing perceived need for natural resource professionals, irrespective of funding initiatives.

These conclusions are based on data from a single two-week pay period in 1993, 1997, 2000, and 2003, and represent a snapshot in time. While aggregate comparisons are valid, the specific information about an individual park is not necessarily valid for another time or on average for that park. A few other limitations of the data should be noted:

- Education levels are sometimes inaccurately or incompletely recorded and are rarely updated to note ongoing or additional education; the information generally reflects only entry-level education.

- The data do not reflect technician-level staff or those in ranger or related positions that may perform natural resource management duties. Undoubtedly, more staff perform natural resource-related duties, although not as professional-level staff, than are indicated by the data. In many instances, nonprofessional resource management positions have been reclassified over the past decade to professional-level positions. These reclassified positions are reflected in this analysis.
- Before 2003, positions were categorized administratively by location: park, regional office, or Washington Office. The park category was expanded in 2003 to include field-based park support units. This change reflects the addition of staff to Exotic Plant Management Teams and Inventory and Monitoring networks, which may be associated with various organizational units, but are all field-based.

Despite shortcomings in the data, a number of additional conclusions are evident. The number of professional resource managers in the National Park Service has more than doubled, from 487 in 1993 to 1,049 in 2003. Certainly this represents growth in numbers of professional staff dedicated solely to natural resource management. But it also likely reflects the replacement of technicians and rangers by resource professionals through a process of job reclassification or through replacement when vacancies occurred. Technicians and rangers often carried out natural resource management duties, although OPM does not consider these positions to be professional resource management positions.

While there has been some growth in positions that are classified as specialists, 62% of all biologists are classified as general biologists. The percentage of professionals in physical science positions has held steady over the decade at about 20%. Biologists made up 88% and 86% of park resource professionals in 2000 and 2003, respectively, and the percentage of these biologists with advanced degrees has grown from 49% to 53% over the same period. This likely reflects the influence of the Natural Resource Challenge, which funded new Inventory and Monitoring personnel and air and aquatic resource professionals placed in the field (see previous articles, this chapter). Many of these staff hold advanced degrees.

All in all, these trends demonstrate significant progress in advancing natural resource management to the professional levels necessary for effective park preservation. ■

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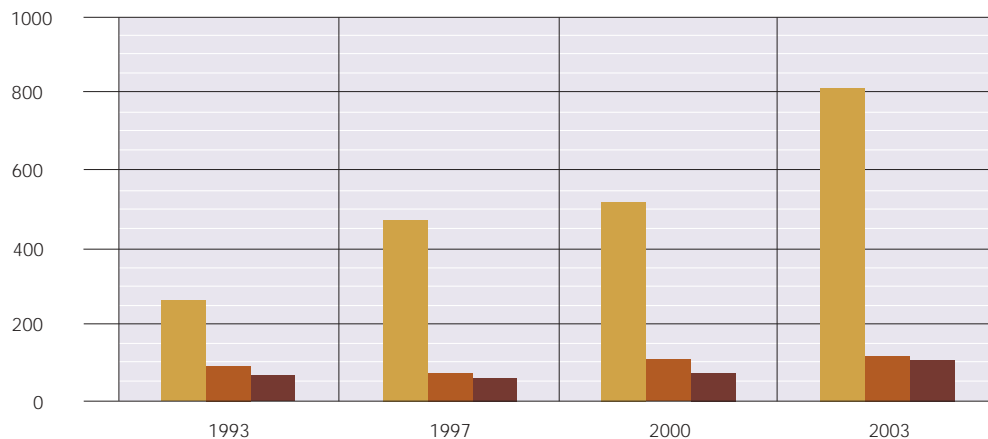
Deputy Associate Director, Natural Resource Stewardship and Science; Washington, D.C.

staffing trends

NUMBERS OF NATURAL RESOURCE PROFESSIONALS BY LOCATION

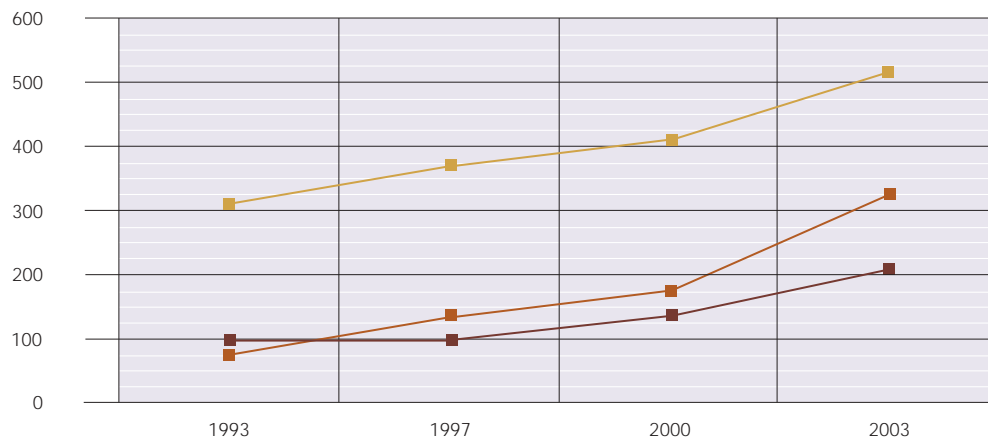
Excludes Denver Service Center, Harpers Ferry Center, and fire personnel

- Parks and I&M Networks
- Regional and Support Offices
- Washington Office



TYPES OF NATURAL RESOURCE PROFESSIONALS

- General Biologists
- Specialized Biologists
- Physical Scientists



NPSFACT

Approximately 70% or 192 of the 272 national parks deemed to have significant natural resources (**I&M parks**) had at least one professional-level resource manager on staff in 2003, compared to about 50% or 134 a decade ago.




Inventory and Monitoring Charges Ahead

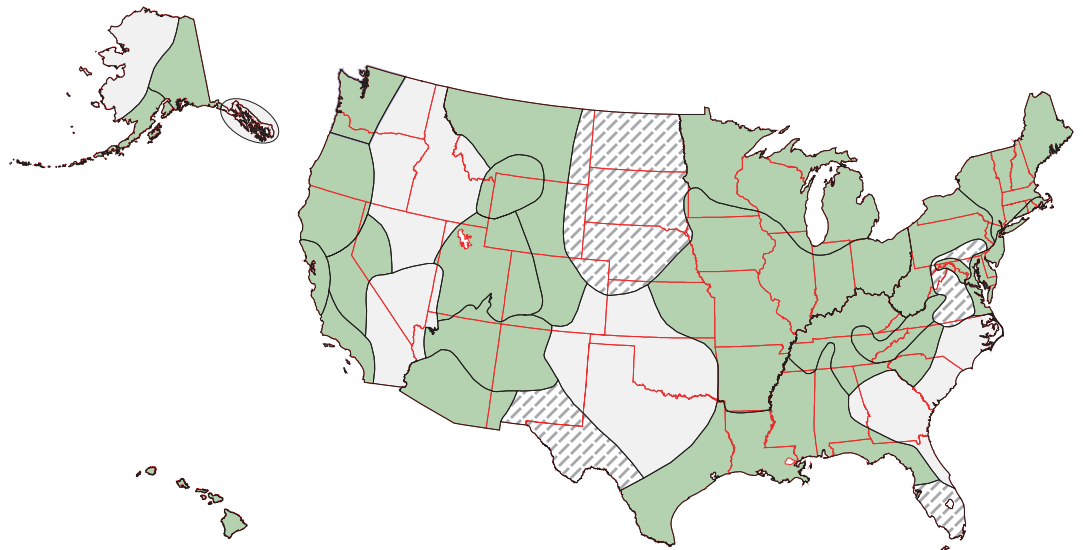
“One of the best weapons for addressing complex management problems is good scientific information. This requires good research.... [and] a tight linkage between research and management.”

—David L. Peterson
National Parks and
Protected Areas: Their Role in
Environmental Protection

In its infancy a decade ago, the Inventory and Monitoring Program flourished in 2003. It has developed from inadequately funded inventories in numerous parks and pilot monitoring focused on just 22 parks to a thriving program that encompasses all national parks—some 270 (called I&M parks)—that have significant natural resources. It owes its success in large part to the organization of the I&M parks into 32 networks designed to document the status and trends of natural resources. Using this strategic approach, parks in the various networks share funding and professional staff, obtained through the Natural Resource Challenge, and partner with hundreds of universities and federal and state agencies to complete basic park resource inventories and monitor the condition of selected resources. The program emphasizes the development of modern database and GIS systems to build institutional knowledge by documenting and organizing the resource information needed for effective science-based, managerial decision making and resource protection. The articles that follow exemplify how parks are benefiting from inventory information and how many parks in the 22 networks funded for monitoring are charging ahead to meet the information and resource protection goals. The next step is to complete all 32 I&M networks, so that, like those in operation, the 10 networks that are not funded can develop the long-term informational tools needed to safeguard the health and integrity of these parks for the future.

PARK VITAL SIGNS MONITORING NETWORKS STATUS FY 2004

-  22 monitoring networks funded FY 2001–2004 for core park vital signs
-  6 monitoring networks proposed for funding in FY 2005
-  Unfunded



Developing institutional knowledge of biodiversity

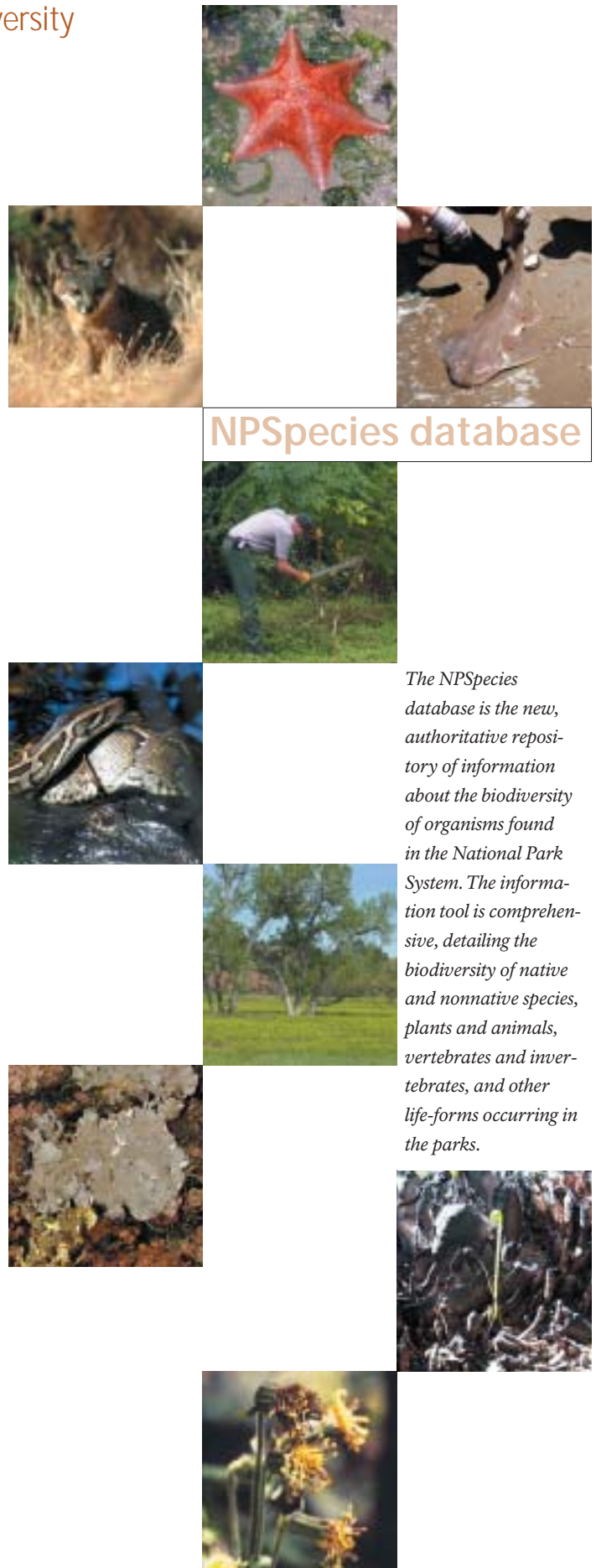
By Mark A. Wotawa

PRESERVING AND PROTECTING our natural heritage require “institutional knowledge” that is readily accessible. Until recently, detailed knowledge of park resources usually resided solely with park researchers and other park staff. The information was lost, having not been integrated into a sustainable format, as key staff members moved on in their careers. NPSpecies—the NPS database for biodiversity, which contains species lists and associated scientific evidence and serves as the core of a larger, integrated information system—changes this situation with respect to biodiversity. NPSpecies will help build institutional knowledge by housing biodiversity information indefinitely for parks, scientists, and the public. NPSpecies also makes the information available for applications beyond immediate park management purposes.

Institutional knowledge in this context results from the collection, organization, and verification of raw field data and their subsequent integration, analysis, and dissemination to produce usable scientific knowledge. Developing institutional knowledge of biodiversity in the National Park System is especially challenging because of the ecologically and physically diverse environments of the national parks, the dynamic nature of biodiversity in a world of changing landscapes, and constant change in taxonomic systems. Also, the many disparate programs and projects that contribute to the information base of biodiversity demand extensive human resources and fiscal support. A system like NPSpecies, which incorporates the information-sharing capabilities of the Internet, helps develop and preserve institutional knowledge of biodiversity efficiently and effectively.

The development of NPSpecies began in 1999 with the conversion of existing data, and later the entry of new data acquired primarily from field surveys of vertebrate animals and vascular plants through the Inventory and Monitoring Program. In 2003, with enhancements to NPSpecies for quality assurance, NPS staff began to conduct formal review and verification of each newly completed field survey. Biologists and taxonomists from numerous NPS partners participated in efforts to collect, organize, review, and verify NPSpecies data, including those from other federal and state agencies (e.g., the U.S. Geological Survey), universities, Cooperative Ecosystem Studies Units, and nongovernmental organizations such as NatureServe and natural heritage programs.

NPSpecies examples include (from top to bottom, left to right) marine and terrestrial animals such as batstar (*Patiria miniata* at Point Reyes National Seashore, California), island fox (*Urocyon littoralis santacruzae* at Channel Islands National Park, California), angel shark (*Squatina californica* at Point Reyes); nonnative plants and animals such as invasive chinaberry (*Melia azedarach* at San Antonio Missions National Historical Park, Texas), python (*Python* sp. at Everglades National Park, Florida), and leafy spurge (*Euphorbia esula* L. at Devils Tower National Monument, Wyoming); and a new species of lichen (*Leioderma* sp.) discovered as part of the All Taxa Biodiversity Inventory at Great Smoky Mountains National Park, Tennessee and North Carolina, a newly discovered fern (*Schizea pennula* at Big Cypress National Preserve, Florida), and endemic *Rugelia nudicaulis*, which occurs only in Great Smoky Mountains in high-elevation areas.



The NPSpecies database is the new, authoritative repository of information about the biodiversity of organisms found in the National Park System. The information tool is comprehensive, detailing the biodiversity of native and nonnative species, plants and animals, vertebrates and invertebrates, and other life-forms occurring in the parks.

Major advances to integrate NPSpecies information, both within and outside the National Park Service, occurred in 2003. In addition to previous integration with the natural resource bibliography (NatureBib), NPSpecies was combined to varying degrees with other NPS information systems. These include the Exotic Plant Management Team's Alien Plant Control and Monitoring (APCAM) database, the Fire-Effects Program Fire Ecology Assessment Tool (FEAT) database, the Natural Resource Management Assessment Program (NRMAMP) database, the natural resource metadata database with its associated GIS map and data archive (NR/GIS Metadata), the Incident Management Analysis and Reporting System (IMARS), and the Automated National Catalog System (ANCS+) of the NPS Museum Management Program.

Outside the National Park Service, the National Wildlife Federation directly integrates verified species lists from NPSpecies and interpretive information in their eNature database to produce park-specific interpretive field guides that will be available over the Internet. Through an online, interactive tool, park staff will be able to tailor the generic multimedia information, including pictures, sounds, maps, and text. In a related cooperative venture with the ALL Species Foundation and Discover Life in America, the interpretive field guides will showcase species previously unknown to science that were discovered in parks, and other significant finds, such as range extensions and new populations. Having this knowledge available in a central location on the Internet (anticipated early 2004) will provide interpreters and educators with a tool to greatly enhance the experience of park visitors.

The U.S. Fish and Wildlife Service has recognized the potential for NPSpecies to document the biodiversity of the National Wildlife Refuge

System. In 2003, NPS staff began discussing how the two agencies could use NPSpecies for information exchange. A partnership arrangement that uses NPSpecies would save human and fiscal resources and provide a common tool for scientists and managers to collaborate on solutions to similar natural resource issues in both parks and refuges.

The final, all-important step in developing institutional knowledge is making the information widely available to all NPS constituents for scrutiny. Development has begun on the public, online version of NPSpecies, with the anticipated sharing of appropriate and verified information starting in 2004. Tools to produce comparative summary statistics for analysis currently are available in NPSpecies, and geospatial tools to integrate products from other inventories, such as vegetation maps, are in development. Making the same information available to scientists and natural resource professionals throughout the world will result in ongoing analyses of information that contributes to the management and protection of natural resources in parks.

The National Park Service continues to support other programs that assist in documenting biodiversity, including the All Taxa Biodiversity Inventory. An oceans program that would help record the biodiversity of marine organisms for 70 coastal parks is on the horizon. NPSpecies has the capability to integrate, analyze, and disseminate information from all of these programs and to ultimately fulfill the vision of accurately and systematically developing institutional knowledge of biodiversity in the National Park System. ■

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Ecologist-Biological Inventory Coordinator, Natural Resource Information Division, Fort Collins, Colorado

award-winner

Brian Carey honored for successfully integrating natural resource management in a "cultural" park



Brian Carey, chief of Resource Management and Visitor Protection at Lyndon B. Johnson National Historical Park (Texas), is the winner of the 2002 Trish Patterson-SCA Award

for Natural Resource Management in a Small Park, awarded in 2003. This park was established to preserve cultural resources, including the Texas White House during its namesake's presidency. Before coming to this park in 1995, Brian worked at three other national parks, but this is his first "cultural" park. Brian's natural resource management activities, such as treating the 55-acre (22-ha) pecan grove using integrated pest management and partnering to remove invasive species from the prairie plots, reflect his belief that preserving and interpreting

cultural resources also require understanding and stewardship of the natural landscape in which they occur.

Balancing the preservation of cultural resources with natural resources can be tricky. For example, at Lyndon Johnson a historic cattle herd has traditionally been pastured and watered along the banks of the Pedernales River, posing two natural resource-related problems: cattle trails along the river are eroding the banks, and movement of the river channel is changing the historical boundaries of the pasture. Which is the most important resource to preserve in this cultural landscape? In this case, under Brian's leadership, the banks of the Pedernales River are being protected with electric fencing; the cattle are being watered at troughs; and native, stabilizing, riparian vegetation is thriving. Whether to restrict the meandering river or to dampen the effects of three old dams in this reach of the

Pedernales River is still being decided.

Beyond his park, Brian has played an important role as co-coordinator of the Southern Plains Vital Signs Monitoring Network. The 11 parks in this network are primarily cultural and recreational units with limited natural resource budgets and staff. Brian has taken the lead in attracting partners and implementing agreements in order to survey the parks and update staff who are unfamiliar with inventory techniques.

Although Brian was a biology major in college, he considers himself a generalist. He says, "I enjoy getting involved with all aspects of the parks. What is especially interesting here is that Lyndon Johnson was so attached to this land rooted in the Texas hill country. You can see that reflected in the natural resources legislation he promoted throughout his career." ■

Making fuels and vegetation data available for fire management

By David Pillmore and Pat Stephen

HOW WILL A FIRE BURN given particular conditions such as wind speed, slope, and humidity? Fire technicians can readily and accurately measure these parameters for input into a model, but two other variables, fuels and vegetation, require a concerted mapping effort and management of data for easy access. In 2003, data managers and fire technicians in the NPS Natural Resource Information Division, Rocky Mountain National Park, and Grand Teton National Park joined forces to design a tool for capturing and transferring information on fuels and vegetation that makes these data readily available for fire management. Their approach is promising and adaptable far beyond high-elevation mountain parks.

The need for such a tool emerged during the development of models for managing fire risk. The vegetation map that fire managers in Rocky Mountain National Park were using as a basis for developing their models was created in 1988 using methods that are outdated by today's standards. Although managers estimated its accuracy at 80% to 85%, the fuel parameters assigned to the various vegetation associations had never been tested in the field.

The efforts behind the prototype fuels-vegetation mapping project involved gathering field and remotely sensed data from 547 plots, which are representative of larger biophysical units that combine vegetation and geographic attributes. Notably, field crews simultaneously recorded fuels and vegetation data, streamlining the mapping process. Field documentation also included numerous photographs from each plot. Aerial photo interpretation, map development, and field testing for accuracy are ongoing.

“The design is flexible.... [and] provides a means for easily exporting data to fire and fuels management applications”

The backbone of the prototype fuels-vegetation mapping project is the management of data through the fuels-vegetation mapping application. Starting with the NPS standard database, Microsoft Access, the application is well designed using standard data models and formatting. Project designers incorporated models such as the Anderson Guide fuel models and Burgan and Rothermel fuel inventories into the database. They followed a standard structure and template, developed by the Inventory and Monitoring Program, to be used for all resource-related studies and created a layout that is compatible with data entry forms used by vegetation mapping crews, which facilitated both data entry and quality control. The application makes plot information and more than 3,000 plot-related photos available for review digitally. A linkage allows the photos to be viewed by querying the plot from within the GIS, enhancing the ability to compare map layers with photographs of the surrounding terrain.



Along Bear Lake Road in Glacier Gorge, Rocky Mountain National Park, field crews inventoried plot #406, simultaneously mapping fuel types and cover with vegetation for input into fire-fuel models. Among the 16 species identified are the conspicuous quaking aspen (*Populus tremuloides*) and eagle fern (*Pteridium aquilinum*).

The design is flexible. For example, repeat visits to build time-series data, for tracking changes over time, can be included and different habitats can be incorporated. The design also provides a means for easily exporting data to fire and fuels management applications like Fuels Management Analyst (FMA) and Forest Vegetation Simulator (FVS). In short, the prototype fuels-vegetation mapping application is a tool for capturing information on fuels and vegetation that can be used for developing better models and testing assumptions about forest growth, fire behavior, and fire-risk analysis.

Managers in Rocky Mountain and Grand Teton National Parks developed similar prototypes in 2003. Many reasons exist for other fire and network data managers with vegetation mapping projects to adopt these prototypes for use in their parks: the application is public domain, the design and database structure are established, the code is written, the links for exporting information into other programs are set, and the electronic forms are in place. Saving time and money, of course, is another factor. In addition, the potential for sharing data through the same data structure and the ease of communication about a similar database make the prototype fuels-vegetation mapping application a powerful starting point for collaboration. ■

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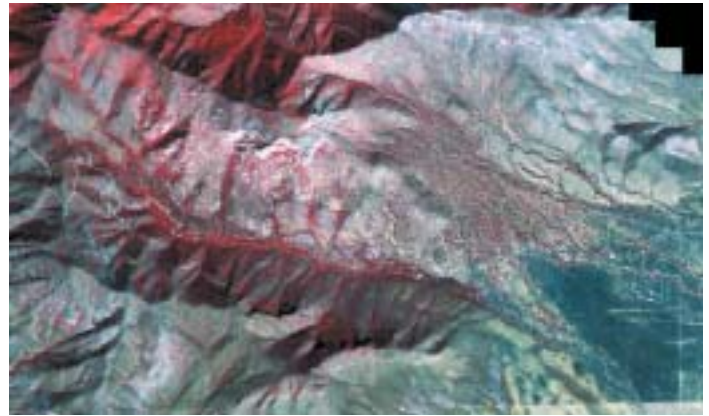
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Remote sensing makes widespread contributions to vital signs monitoring

By John Gross

LOGISTICAL DEMANDS REQUIRED to monitor natural resources frequently challenge the networks of parks that have been established for inventory and monitoring. Areas of concern may be large, rugged, remote, or even submerged, and physically collecting data may be expensive, dangerous, and sometimes impossible. Furthermore, ecologically important processes—including fire, windthrow, and vegetation change—can occur on such vast, landscape scales that ground-based monitoring is simply not practical. To address these needs, monitoring networks are rapidly integrating remotely sensed data into monitoring programs and collaborating with partners to develop novel techniques to better use “data from space.” In 2003 alone, at least eight networks used remote sensing to aid in managing fires, creating vegetation-fuels maps, and monitoring the effects of invasive plants and changes in land use.

Mitigating the spread of invasive plants depends on up-to-date information about distribution and abundance. Resource managers routinely have used high-resolution, remotely sensed data to identify woody weeds, where structural (rather than spectral) attributes contributed to easy identification. Distinguishing between species of herbaceous plants is usually not possible from remotely sensed data, but researchers from the U.S. Geological Survey (USGS) collaborated with staff in Canyonlands National Park (Utah) to combine spectral signatures and temporal patterns to identify and map the occurrence of cheatgrass (*Bromus tectorum*), a highly invasive, nonnative species. The ability to identify and map cheatgrass will vastly improve the efficiency of monitoring efforts by reducing



This IKONOS satellite image of Coronado National Memorial, Arizona, reveals variation in plant species distribution and density that results from environmental differences in slope, aspect, soils, and land management practices. The sharp angle near the top and the horizontal line near the bottom of the image reflect much higher grazing pressure from cattle outside the fenced memorial boundary. Many of the roads near the right edge of the image were created by illegal immigration and smuggling. Information from remotely sensed images is valuable for assessing the natural resource impacts of illegal transit through the park for fire management planning, vegetation mapping, and evaluating land uses along park boundaries that may affect park resources.

“The Sonoran Desert Network is examining the use of high-resolution IKONOS satellite imagery to detect and map human impacts on desert environments.”

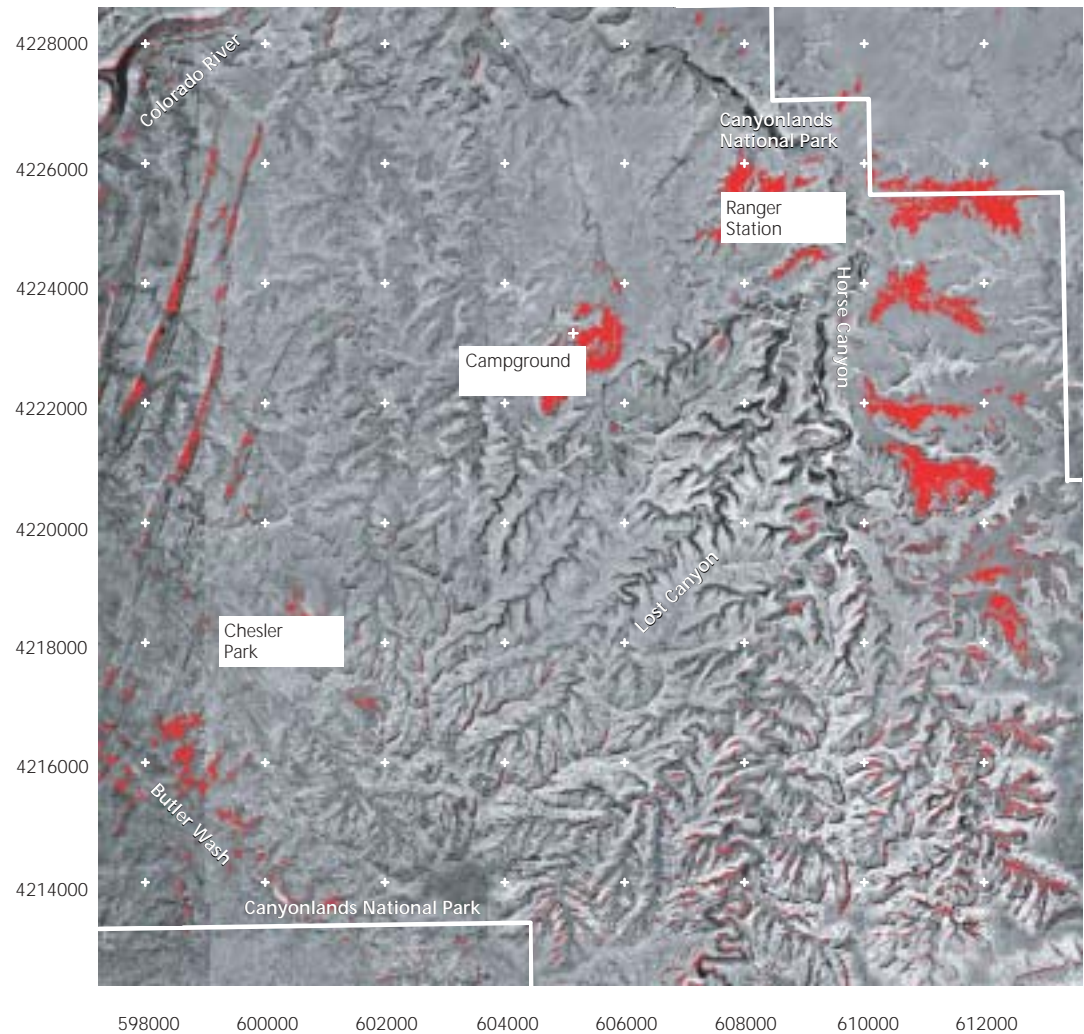
the area that needs to be examined through ground-based sampling. Remotely sensed data also provide a means to extend routine monitoring, based on satellite imagery, to much larger areas in the extremely rugged and remote parks on the Colorado Plateau.

Another important application of remotely sensed data is the evaluation of changes in land use. Scientists have repeatedly identified changing land-use patterns as one of the most important long-term threats to park resources. Five Inventory and Monitoring networks are collaborating with universities and the USGS to develop protocols using remotely sensed data to monitor and evaluate consequences of land-use change in and near more than 50 units of the National Park System. In the Northeast the smaller size of parks and higher intensity of land use justify analyses based on high-resolution satellite data. In other areas where the scales of analysis

are broader, lower-resolution satellite imagery (e.g., Landsat, Modis, ASTER) will be an important component of integrated analyses that combine imagery with spatially explicit databases that include information on population size, home density, and other indicators of land use. When integrated, these sources provide a rich picture of the changing landscape in which parks are embedded.

Natural Resource Year in Review—2002 (see page 57) documented a smaller-scale change in land use within parks: the impacts of large numbers of illegal immigrants and smugglers moving through parks on the U.S.-Mexican border. This problem is especially acute in Organ Pipe Cactus National Monument (Arizona), where impacts include trails, off-road vehicle tracks, and construction of temporary shelters. Dangers posed during confrontations with smugglers limit the ability of the National Park Service and its partners to conduct field surveys to identify travel routes and impacts. In collaboration with researchers from the University of Arizona and with support from the NPS Mexican Affairs Office, the Sonoran Desert Network is examining the use of high-resolution IKONOS satellite imagery to detect and map human impacts on desert environments. Field investigators have confirmed accurate identification of paths, temporary shelters, and unauthorized roads on satellite imagery. Comparisons with images from the mid-1990s have clearly revealed a dramatic increase in resource damage over a period when changes in law enforcement led to propagation of travel through remote park locations.

Satellite remote sensing is being used to detect areas potentially infested by invasive cheatgrass (*Bromus tectorum*), shown in red, in Canyonlands National Park, Utah. For this image, researchers compared Landsat 7 Enhanced Thematic Mapper data collected on April 15, 2001, when cheatgrass was green, with those gathered on July 4, when the grass was brown. The vegetation growth cycle of cheatgrass contrasts with that of native vegetation on the Colorado Plateau, which facilitates identification of cheatgrass-infested areas. The background image is derived from digital orthophotos.



In collaboration with the NPS fire program, managers extensively use aerial photographs and satellite imagery to simultaneously map vegetation and collect data on fuel loads (see article on page 37). Furthermore, the fire program uses contemporary aerial photographs and satellite data to map the extent of fires, estimate burn severity, and evaluate recovery rates over short and long periods.

Remotely sensed data are used throughout the National Park System for inventory and monitoring applications to address key information needs in natural resource management. This information will be increasingly important to monitoring programs as the quality of data improves and the price to acquire them decreases. ■

“Monitoring networks are rapidly integrating remotely sensed data into monitoring programs and collaborating with partners to develop novel techniques to better use ‘data from space.’”

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LIDAR in paradise: An alternative method for coral reef mapping and monitoring in the U.S. Virgin Islands

By Matt Patterson and Britton Wilson

SHALLOW CORAL REEFS in the Caribbean Sea were once dominated by elkhorn coral (*Acropora palmata*), but in the 1980s and 1990s, white disease nearly wiped out the genus. This species was generally found atop the reef crest where its massive branches helped protect coastlines by reducing wave impact from approaching storms. These structures also provided refuge to many species of reef creatures and created excellent opportunities for snorkelers to experience thriving coral reef ecosystems.

For several years the species has been attempting a comeback in several of the U.S. Virgin Islands national parks, where coral reef scientists have documented nearly 4 inches (10 cm) of growth per year. Ironically, the growth of the delicate branches has thwarted scientists' efforts to monitor change in the colony. As they grow, the branches fuse, creating a lattice of living creatures that is easily disturbed. Fortunately, a new mapping and monitoring method has emerged that does not disturb sensitive reef species and that increases the information available to resource managers.

Researchers based at NASA's Wallops Flight Facility (Virginia) and the USGS Center for Coastal and Watershed Studies (Florida) have developed a new airborne sensor, the NASA Experimental Advanced Airborne Research Lidar (EAARL), which assists scientists and managers of these precious resources. The sensor uses **lidar** (light detection and ranging) technology to rapidly survey elkhorn coral colonies, determining total area and mapping the microtopography of the sites. The technique also documents the surrounding terrestrial and

marine resources. The NASA EAARL instrument is attached to a fixed-wing aircraft and continuously transmits laser pulses, capturing the time-amplitude history of their reflections. The resulting "laser wave forms" are used to map the elevation of the ocean substrates and to generate three-dimensional information on vegetation canopies. In 2003 the South Florida/Caribbean Network coordinated with the USGS and NASA to collect lidar data from many of the network parks with coral reef resources.

By combining the lidar data with ground-based research findings, scientists are able to gain new information. A larger-scale application is comparing the mass of a complex coral reef with a barren seafloor. First, park resource managers collect location data for coral reefs using global positioning systems. They then combine the information with 1-meter-resolution lidar data to approximate the mass of an individual coral species for a park. Whereas measuring the mass of thousands of individual coral colonies could take months, this combination approach provides results in much less time. This baseline information will be critical to network parks as they begin to monitor the species' recovery and evaluate the impacts of future storms on this key marine resource. ■

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SPRING 2003 EAARL FLIGHTS OVER ST. JOHN, U.S. VIRGIN ISLANDS

In 2003 the South Florida/Caribbean Monitoring Network, in partnership with the NASA Wallops Flight Facility and USGS Center for Coastal and Watershed Studies, deployed lidar, a relatively new aerial survey tool that can be used to monitor sensitive coral reefs. Flights over Virgin Islands National Park were extensive in spring 2003 and resulted in useful information on the location, extent, and mass of the park's reefs.

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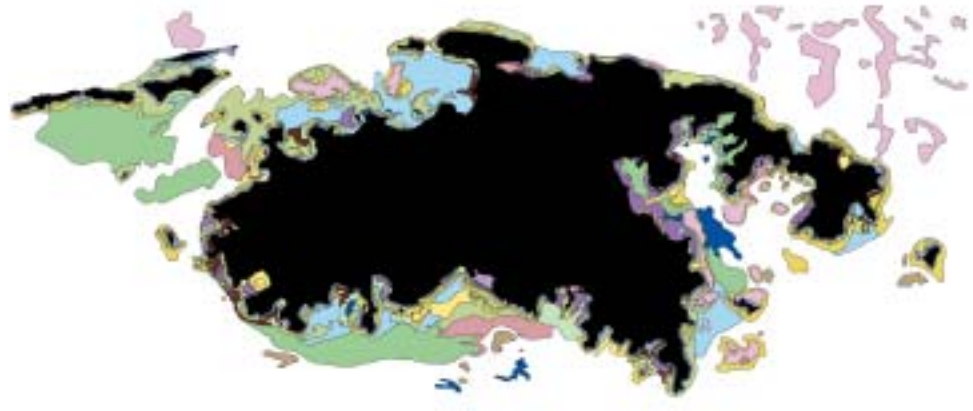


Marine inventory to pay monitoring dividends in Caribbean parks

By Jim Petterson

HYPER-SPECTRAL IMAGE OF BENTHIC HABITATS AROUND VIRGIN ISLANDS NATIONAL PARK, ST. JOHN

- Hardbottom/Reef Rubble
- Hardbottom/Uncolonized Bedrock
- Land
- Macroalgae/Patchy/10–50%
- Macroalgae/Patchy/50–90%
- Mangrove
- Mud
- Reef/Colonized Bedrock
- Reef/Colonized Pavement
- Reef/Colonized Pavement with Channels
- Reef/Linear Reef
- Reef/Linear Reef (Aggregated)
- Reef/Linear Reef (Individual)
- Reef/Scattered Coral-Rock
- Sand
- Seagrass/Continuous
- Seagrass/Patchy/10–30%
- Seagrass/Patchy/30–50%
- Seagrass/Patchy/70–90%
- Unknown



AN AMBITIOUS MARINE inventory program in the Caribbean national parks is paving the way for the development of an integrated fish monitoring program throughout the South Florida/Caribbean Monitoring Network. The inventory is being conducted cooperatively by staff of Virgin Islands National Park, the recently authorized (2001) Virgin Islands Coral Reef National Monument, Buck Island Reef National Monument, the National Oceanic and Atmospheric Administration (NOAA) Biogeography Program, and the Caribbean Field Station of the USGS Biological Resources Division.

The project is ongoing and builds on results from an extensive fish inventory of the waters around St. John that began in 1995 with the establishment of the prototype Long-Term Ecological Monitoring Program at Virgin Islands National Park. These efforts demonstrated that accurate marine habitat maps were needed in order to monitor fish for the long term, and in 1998, NOAA undertook efforts to produce habitat maps of the ocean floor surrounding Puerto Rico and the U.S. Virgin Islands. The maps were based on aerial photos and hyper-spectral imaging, which is rich in detail. The staff at Virgin Islands National Park, Buck Island Reef National Monument, and the USGS played integral roles in the subsequent accuracy assessments of the maps. Their efforts required scuba-diving visits to randomly selected sites to describe biotic habitat features and topographic complexity. At the same time they sampled macroinvertebrates and reef fish using transect and point count techniques.

To date, approximately 450 sites have been characterized in Virgin Islands National Park (see map) and Buck Island Reef National Monument. The accuracy of the habitat maps has been verified and valuable information pertaining to the biodiversity and health of the parks is available. Particularly noteworthy is the documentation of the extremely diverse and healthy coral reef communities in the deeper water regions of Virgin Islands Coral Reef National Monument and previously unidentified high-diversity patch reefs hidden among seagrass beds at Buck Island Reef. The inventory staff selected sample sites randomly from the two dominant marine communities—reef hardbottom and seagrass beds—both inside and outside park and monument boundaries. This sampling strategy will allow comparisons between the no-take areas in the monuments and the adjacent waters outside the designated marine protected areas, where harvesting is permitted, to test for differences in habitats and biotic communities.

The next step, which the network partners began in 2003, is to use the fish population sampling data to develop a robust reef fish monitoring protocol that can be applied to all the marine parks in the South Florida/Caribbean Monitoring Network. ■

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Seals and sea lions: Indicators of marine ecosystem condition at Point Reyes

By Sarah Allen

PARK RESOURCE MANAGERS are identifying species that can give them insights into the condition of natural systems in the nation's parks through the Inventory and Monitoring Program, a major component of the Natural Resource Challenge. Changes in populations of top predators, for example, provide early warning signals of disruptions in natural systems. Seals and sea lions, as the apex predators of Pacific Ocean marine ecosystems, were selected in 2003 by the San Francisco Bay Network as indicators for ecosystem condition at Point Reyes National Seashore.

Seals and sea lions, known as pinnipeds, are excellent indicators because the protocols for monitoring these animals are well established and easily implemented. Additionally, other marine parks and agencies, including Channel Islands National Park and the National Oceanic and Atmospheric Administration, monitor



Northern elephant seals (left and right) congregate to breed at Point Reyes National Seashore, California, home of the northernmost colony of these animals. Six species of seals and sea lions, federally protected marine mammals, occur at Point Reyes. Park managers are monitoring seal colonies to detect changes in natural systems and to adaptively manage park resources and activities to benefit seal populations.

Biologists have determined that populations of both species have increased significantly within the seashore over the past 20 or more years; however, individual colonies have experienced uneven recovery rates depending upon human activities. Point Reyes National Seashore has responded with various adaptive management strategies. At Drakes Estero, for example, park managers detected a decline in population numbers and determined that increased kayak use was disturbing the breeding seals. In response the park instituted a seasonal closure of the area to kayaking, and the recovery of the colony was documented in subsequent breeding seasons.

Monitoring several colonies has allowed biologists to distinguish broad-scale environmental effects, such as climate variability from human-caused disturbances, on individual colonies. Researchers may also detect regional or global trends by linking regional pinniped monitoring data with other indicators such as water quality, weather, and marine fish populations. The scientific information obtained through monitoring gives park managers a better understanding of how to sustain and restore species like the seals of Point Reyes National Seashore. ■

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“At Drakes Estero... park managers detected a decline in population numbers and determined that increased kayak use was disturbing the breeding seals. In response the park instituted a seasonal closure of the area to kayaking, and the recovery of the colony was documented in subsequent breeding seasons.”

pinnipeds, providing opportunities for regional collaboration on analysis. These animals also have special status under the Marine Mammal Protection Act because of special requirements for their protection and, in some cases, because of the precarious status of species.

Monitoring at the seashore focuses on the two breeding species of pinnipeds, harbor seals (*Phoca vitulina richardii*) and northern elephant seals (*Mirounga angustirostris*), although six species of pinnipeds occur there. The topographic and hydrographic complexity of the coastal zone of Point Reyes National Seashore provides diverse habitats for seals and their prey. Harbor seals are the dominant and most widespread pinniped in the park, hauling out throughout the year at nine terrestrial sites. Point Reyes National Seashore is also the northernmost breeding colony for northern elephant seals.

Since 1976, researchers have monitored seal colonies at Point Reyes National Seashore to detect changes in population numbers and reproductive success and to identify factors that might affect population trends. During surveys, staff and trained volunteers collect demographic data, including the total number of animals by sex and age class and number of pups. Information is also collected on environmental factors (e.g., weather, shoreline changes) and human disturbances (e.g., sources of disturbance impacts on seal behavior).

NPS FACT

Visitors to the approximately 270 national park units that are considered to have **significant natural resources** (I&M parks) numbered 231.6 million in 2002, or **84% of total visitation** in the National Park System. Visitation at the I&M parks dropped 0.6 million from 2000 to 2002 compared to an overall decline in National Park System visitation of 8.6 million for the same period.



Channel Islands National Park seeks expert recommendations to enhance monitoring programs

By Kathryn McEachern

Channel Islands National Park (California) was one of the first four parks to obtain funding to create a Prototype Ecological Monitoring Program. Prototype programs serve as “centers of excellence,” conducting more in-depth monitoring and information gathering to benefit all of the approximately 270 parks with significant natural resources. Important elements of prototype programs are the evaluation of monitoring efforts and the development of better sampling and assessment methods for parks in each of 10 major biomes. With this in mind the U.S. Geological Survey–Biological Resources Division (USGS-BRD) in 2000 initiated an expert review of the vegetation and land bird monitoring programs of Channel Islands National Park. Suggestions from the review were implemented in 2003.

The USGS-BRD Channel Islands Field Station convened a panel of experts to review more than a decade’s worth of data and the programs’ monitoring protocols in 2000. The panel provided comments and recommendations to the National Park Service that are designed to improve the effectiveness and efficiency of the monitoring programs. Program revisions based on the findings are being designed and tested by USGS-BRD and NPS scientists. For example, transect sample efforts, which have been extensive in the past, are being strategically redesigned to free resources for other monitoring needs identified by the review, such as vegetation mapping. Similarly, the land bird monitoring program has been changed to place emphasis on analyses of bird abundance by habitat for all five of the park’s islands. Another change is improvement of both monitoring programs’ databases to enable better integration of information across habitats and to streamline annual report preparation. Improving and deepening the information available to park managers allow them to better respond to the changes affecting park natural resources. ■

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Resource managers monitor a coastal scrub plant community transect at San Miguel Island, Channel Islands National Park. In 2003 the National Park Service began to implement recommendations from a scientific review of the park’s vegetation and land bird monitoring programs.

Repeating history: Vertebrate inventory in Yosemite National Park

By Leslie S. Chow

HOW OFTEN do we get to repeat important historic moments? In the summer of 2003, scientists from the University of California–Berkeley Museum of Vertebrate Zoology and the U.S. Geological Survey (USGS) had the opportunity to repeat some of the historical vertebrate surveys conducted by Joseph Grinnell in Yosemite National Park. The first broad survey of Yosemite National Park wildlife in more than 80 years was made possible through a cooperative effort with both organizations and the National Park Service’s Inventory and Monitoring Program.

Joseph Grinnell and the university’s Museum of Vertebrate Zoology conducted vertebrate surveys from 1914 to 1920 along a transect that ran from the Central Valley of California, through Yosemite National Park, to the Great Basin Desert near Mono Lake. The Grinnell Survey collected more than 4,000 specimens, recorded 2,001 pages of handwritten field notes, and took nearly 1,400 photographs. The resulting report, “Animal Life in the Yosemite,” remains the most comprehensive documentation of Yosemite’s vertebrates.

In 2003, scientists revisited five of the original Grinnell sites in the park. Preliminary results suggest that the distribution of several species has changed. One of the most common shrew species recorded by Grinnell in Yosemite Valley appears to have been replaced by another shrew during the intervening years. Golden-mantled ground squirrels no longer appear to inhabit the Merced Grove of giant sequoias as they did in Grinnell’s time, although they were found at higher elevations. And two chipmunk species thought to be relatively common have yet to be found. Whereas some species may have been displaced, others have appeared in surprising locations. The western harvest mouse (*Reithrodontomys megalotis*), not previously known in the park, was caught in Yosemite Valley, and a low-elevation woodland mouse (*Peromyscus truei*) was found at Mount Lyell (10,600 ft, 3,233 m) and Glen Aulin (7,800 ft, 2,379 m).

Although it is not yet clear why these changes have happened, possible factors include warmer average temperatures and the increased density of vegetation from fire suppression. To better understand the changes occurring in Yosemite National Park, museum staff and USGS biologists will continue the survey for the next two years thanks to a grant from The Yosemite Fund. ■



Jim Patton, project leader and curator of mammals at the UC Berkeley Museum of Vertebrate Zoology, weighs a mouse (*Peromyscus maniculatus*) live-trapped from the Merced Grove of giant sequoias.

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Documenting species and sites through bird inventories

By Carol Beidleman with Nikki Guldager, Stephen Fetting, David Mizrahi, and Robert Kuntz

BIOLOGICAL INVENTORIES are a critical first step in effective management of park resources. Protecting species that do not use national park habitats throughout the year, such as migratory birds, presents a special challenge. Given the decline in migratory bird populations, documenting their presence and use of park habitats is important for ensuring the survival of these species.

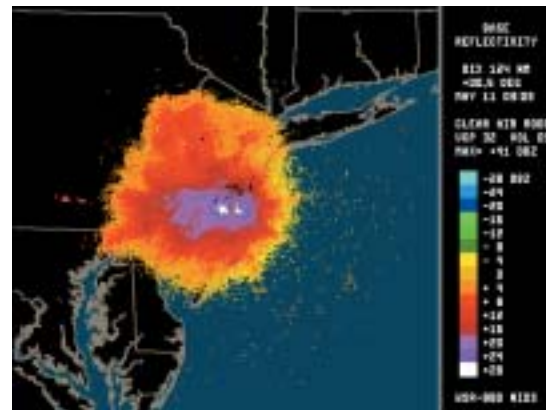
Bird inventories are 1 of 12 core inventories being conducted in approximately 270 parks with significant natural resources. The goal of these inventories is to document 90% of the species that occur in the parks, to document abundance and distribution for selected groups of high-priority species, and to form the basis for developing effective long-term monitoring programs for these species.

“Protecting species that do not use national park habitats throughout the year, such as migratory birds, presents a special challenge.”

Inventory efforts may focus on species or sites used by species. Several examples come from the Park Flight Migratory Bird Program, which works to protect migratory bird species and their habitats in U.S. and Latin American national parks and protected areas through bird conservation and education projects and technical exchange.

In Gates of the Arctic National Park and Preserve (Alaska, photo, page 46), the Park Flight Program and the National Park Service Inventory and Monitoring Program provided support to conduct land bird and shorebird inventories. Gates of the Arctic includes 8.2 million acres (3.3 million hectares) in the central Brooks Range, an extensive and largely unsurveyed landscape with important nesting habitat for numerous migratory bird species. At the park level, baseline information can be used to assess impacts of potential management issues and natural disturbances on species distribution and habitat. Inventory data will also be incorporated into the statewide bird monitoring program developed by Partners in Flight, which focuses on regional trends in population abundance and distribution throughout Alaska. At the global level, many migratory species face widespread loss of habitat in critical feeding and staging areas along migration routes and in wintering areas, and impacts of these threats may be detected first through changes in bird abundance and distribution on breeding grounds. Data from the shorebird inventories, which are conducted by the Alaska Science Center, will be shared with a new Park Flight project in Argentina where some of these species winter.

In New Mexico, a Park Flight project conducted a species inventory through participation in a statewide Breeding Bird Atlas. This project, involving Bandelier, Aztec Ruins, Capulin Volcano, and Fort Union National Monuments, and Pecos National Historical Park,



The New Jersey Audubon Society is using an innovative approach for monitoring stopover areas used by nocturnally migrating songbirds. Every night during spring and fall migration they evaluate National Weather Service Doppler radar (NEXRAD) data to determine if a migration is under way. If it is (top image, made May 10, 2001, at 11:03 p.m. EDT), then they examine data collected as migrants depart on the same evening (bottom image, made about three hours earlier), to determine areas they occupied before their exodus. By identifying these sites, the society can recommend land acquisition priorities or encourage conservation practices where other land uses might prevail.

is a reminder that national park units established to protect cultural resources still have natural resource management responsibilities and play an important role in the conservation of migratory birds. Breeding Bird Atlas information, which documents breeding status, is a key component in basic understanding of ranges and trends of breeding birds and a key building block in any statewide bird conservation effort. Including national park areas in an atlas is critical for evaluating potential causes for bird population trends, because changes to parklands are often minor compared with development or habitat destruction on nonpark lands.

Another Park Flight project, at the New Jersey Coastal Heritage Trail Route, focuses on developing an inventory of important migratory bird stopover sites. This unit works through partners, such as the New Jersey Audubon Society, to promote resource awareness

Wildlife Biologist and Park Flight Manager Nikki Guldager surveys birds during an inventory in the Killik River area of Gates of the Arctic National Park and Preserve, Alaska. The goal of the inventories is to assess avian species diversity, density, and habitat within the park and to develop a monitoring plan.



and protection. New Jersey is a major thoroughfare for large numbers of Neotropical songbirds during spring and fall migration. The availability of suitable stopover habitats that provide the food resources necessary for birds to accumulate energy quickly and safely is essential. National Weather Service Doppler radar is an effective approach for identifying stopover habitats (see image pair, page 45) because it can monitor bird movements at spatial and temporal scales and provide information about site-use frequency and bird density at particular sites. Combining radar data with land-use and land-cover data in a Geographic Information System leads to determining the use of specific habitat types by migratory birds during stopovers. This information is crucial for ranking the importance of particular sites and for making sound land management decisions regarding the conservation of habitats used by songbirds during migration stopovers.

A different kind of migratory bird site inventory has taken place at North Cascades National Park (Washington) as part of a broader regional effort. Here the focus was on the black swift, a species that is not effectively surveyed by standardized approaches for broad-scale landscape- or habitat-based monitoring, such as the roadside Breeding Bird Survey. The black swift is a Partners in Flight Continental Watch List Species, a priority species in the Northern Pacific Rainforest Bird Conservation Region, and a priority species in Bird Conservation Plans for Oregon, Washington, British

“National park units established to protect cultural resources ... play an important role in the conservation of migratory birds.”

Columbia, and Alaska. Prior to this project, no survey of this species had ever been conducted in the Cascade Range of British Columbia and Washington. Because black swifts breed on steep canyon walls close to waterfalls, a special protocol is required to determine their distribution and abundance. Roberto Quintero-Dominguez, a Park Flight international intern from Mexico, was part of a team of NPS employees and North Cascades Institute graduate students who conducted these physically challenging inventories of selected waterfalls in North Cascades. The high percentage of swifts observed at waterfalls and the large number counted on individual surveys suggest that falls within the park are extremely important nesting habitat for this species. ■

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Understanding land bird diversity in the Klamath region

By Daniel A. Sarr, Nat Seavy, John D. Alexander, and Paul Hosten

What drives bird diversity in the Klamath region in the Northwest? Scientists are learning that fundamental conservation questions such as this often must be addressed through landscape-scale analyses. Therefore, network Inventory and Monitoring programs, other federal agencies, and nonprofit conservation organizations are partnering to consider regional needs through development of consistent inventory data sets across park and agency boundaries. For example, scientists who analyzed data collected during field inventories of land birds in



Yellow-rumped warbler, a species that prefers high elevations, is abundant at Crater Lake National Park (high elevation), less common in Cascade-Siskiyou National Monument (middle elevation), and nearly absent from Whiskeytown National Recreation Area (low to middle elevation).

three federal conservation preserves believe environmental conditions, such as climate and habitat, may be important drivers of bird diversity patterns in the Klamath region.

In 2003, scientists from the National Park Service (NPS) Inventory and Monitoring Program, the Bureau of Land Management (BLM), and the nonprofit Klamath Bird Observatory jointly studied bird diversity in Crater Lake National Park, Oregon (administered by NPS); Cascade-Siskiyou National Monument, Oregon (BLM); and Whiskeytown National Recreation Area, California (NPS). Crater Lake National Park, which has diverse and pristine habitat but a cool climate, supported a lower diversity of birds (38 species recorded) than the warmer, lower-elevation parks. Whiskeytown National Recreation Area, the lowest, warmest preserve, however, was apparently no richer in species than Cascade-Siskiyou National Monument, which occupies intermediate elevations (70 vs. 78 bird species recorded, respectively).

Cascade-Siskiyou straddles the crest of the Cascade Range and has exceptional variability in climate and vegetation, which may explain its high bird diversity. Most bird species showed peak abundance in either Crater Lake or Whiskeytown, suggesting that many bird species have preferences for either high or low elevations during their breeding season. However, each of the three preserves supports distinctive and complementary bird species, suggesting they play different roles in the conservation of regional land bird diversity. ■

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Frontiers for Science and Natural Resource Education



“We can live more fully, more pleasantly, more productively, if we try to understand the world of nature.”

—Marston Bates
The Forest and the Sea

In a world in which the sprawl of development for human habitation is overwhelming the biologically diverse landscape, the national parks are oases for nature where wildlife and plant life can thrive and the physical features of the land, air, and waters can be appreciated. The parks are opportunities waiting for scientists to come and study. The National Park Service is striving to make the parks more accessible to scientists through the Natural Resource Challenge, and scientific research and collecting permit numbers are on the rise. As a result, species new to science are coming to light, the ranges of known species are being redrawn, and aspects of the physical landscape that are not easily accessible are now being examined. New technology is allowing researchers not only to investigate nature, but also to share information with the public in ways that were never before possible, as the stories in this chapter demonstrate.

A relatively uncommon family of beetles, glowworms (*Phengodes* sp.) are closely related to fireflies. Adult females are wingless, luminescent, and look like larvae. This specimen, a male, was collected in Great Smoky Mountains National Park as part of the All Taxa Biodiversity Inventory and has been helpful in understanding the distribution of this insect group.



approx. 0.8 inch (2 cm)



New ATBI species discoveries top 3,000 at Great Smokies

By Becky Nichols and Keith Langdon

THE GOAL of the All Taxa Biodiversity Inventory (ATBI) is to discover the species that occur in the 849-square-mile (2,200-sq-km) Great Smoky Mountains National Park (Tennessee and North Carolina). Sampling is to be done in such a way as to obtain distributional and abundance data and to elicit ecological information. All species, regardless of domain (i.e., Archaea, Bacteria, Eucarya) or kingdom (e.g., plant, animal), are targeted for inclusion. Furthermore, the ATBI actively involves students and other members of the public. The National Park Service and its partners in this project are hopeful that this exposure will lead to the recruitment of a new generation of scientists and nurture a science-oriented citizenry. This prototype effort is accomplished through a nonprofit partner, Discover Life In America (DLIA).

In 2003, ATBI activities continued to gear up—a “beetle blitz” attracted coleopterists from across the United States in June, and multiple taxonomic working groups (called TWiGs) benefited from a “high county quest” in July. Additionally, the ATBI has developed a new relationship with the National Biodiversity Information Infrastructure (NBII) node for the Southern Appalachians, resulting in a significant upgrade of the ATBI website (www.dlia.org) and data management functions. Participating scientists received \$400,000 in funding from the National Science Foundation (NSF) to complete the algae portion of the ATBI, and slime mold researchers obtained a \$2 million NSF Planetary Biodiversity award for a global study that will include Great Smoky

“The ATBI is not funded by the Natural Resource Challenge or Natural Resource Preservation Program.”

Mountains National Park. Annual operations for this project are mostly dependent on funding from the Friends of the Smokies and the Great Smoky Mountains Association. (The ATBI is not funded by the Natural Resource Challenge or Natural Resource Preservation Program.)

At the annual conference in December, Dr. Peter Raven, the world-renowned botanist and an advocate of biodiversity conservation, delivered the keynote address. He stressed the need for more efforts like the ATBI. The idea may be catching on, as representatives from other parks and reserves took part in a pre-conference session to learn how to undertake intensive biodiversity inventories.

By December 1, 2003, a total of 410 species new to science had been discovered. An additional 2,955 species constituted new records for the park, bringing the total of new discoveries to 3,365. ■

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The adult male dobsonfly (*Corydalus cornutus*), also collected as part of the All Taxa Biodiversity Inventory, looks as if it can inflict a painful bite, but actually does not have the strength to do so. The larvae of this species, called hellgrammites, occur in a wide variety of aquatic habitats and are predaceous; adults are terrestrial.

Rocky intertidal monitoring partnerships aid management at Cabrillo National Monument

By Bonnie J. Becker

CABRILLO NATIONAL MONUMENT (California) administers a small (120-acre, 49-ha) but very well-protected tidepool area adjacent to the mouth of San Diego Bay. The educational, recreational, and spiritual opportunities afforded by this place are directly dependent on the park's ability to effectively manage marine resources, which in turn depends on access to accurate information on the state of those resources. For 13 years park staff and an army of volunteers have been monitoring 13 key marine species that serve as indicators of the ecological condition of this rocky shoreline. In 2003 the interpretive power of the monitoring data has been greatly strengthened through partnerships, allowing park staff to draw conclusions about the success of management in the park and the region.

This monitoring program, in addition to a number of similar programs in the region, was adapted from techniques used at Channel Islands National Park. In 1997 these programs joined to form MARINE, the MultiAgency Rocky Intertidal Network, an association of 23 academic, private, federal, and local agencies (www.marine.gov), representing 57 sites in six California counties. MARINE is administered by the Minerals Management Service and is dedicated to standardizing the techniques used to monitor the rocky shoreline of southern California and compiling the resulting data. In 2003, MARINE completed the onerous task of forming a centralized database, allowing the first regional view of intertidal systems.

Through this partnership, data collected at Cabrillo can be put into a larger context. Park staff has been documenting the sizes of the

giant owl limpet, a primitive snail related to the valued and threatened abalone. Dr. Jack Engle (University of California [UC] Santa Barbara) is monitoring limpets at four MARINE sites, 2 to 20 miles (3.2 to 32 km) north of Cabrillo, with funding from the U.S. Navy. Limpets at these sites are minimally protected from harvesting. Harvesting as a food item leads to removal of the largest individuals from the population. This difference is reflected in the data: the average Cabrillo limpet was more than 40% bigger than at the nearby sites.

“Four species of snails, including the owl limpet, are significantly larger at Cabrillo than at any other site in the Southern California Bight.”

In 2003, Dr. Kaustav Roy (UC San Diego), Engle, and park staff published a study demonstrating that this effect is widespread (*Ecology Letters* [2003] 6:205–211). Four species of snails, including the owl limpet, are significantly larger at Cabrillo than at any other site in the Southern California Bight. Museum samples and living specimens from the area were measured, revealing that the current snails are much smaller than samples collected before 1960, when the human population was much lower. However, Cabrillo snails are the same size as or larger than they were before 1960, and are much larger than in the years after 1960. Larger individuals are usually much more fecund

One of 13 marine species monitored at Cabrillo National Monument, giant owl limpets (page 51) are significantly larger in the park's protected tidepools than in nearby areas that are minimally protected. Research findings published in 2003 link the larger size of several marine organisms in park tidepools, a resource enjoyed and appreciated by local and visiting tourists alike, to the park's protection strategies.



than smaller ones. Additionally, selectively removing large limpets leads to a gender imbalance; all are born males that become females as they grow. Both of these circumstances lead to decreased reproduction.

For many people a visit to Cabrillo represents one of the few interactions they will ever have with marine life, and the quality of that experience is related to the condition of the resource. The Cabrillo tidepools are well-known for their quality and are preferred by both locals and visiting tourists over nearby tidepools where harvesting is allowed or limitations are not enforced. Visitation to the park is extremely high; up to 384 visitors have been counted in a single hour.

“The Cabrillo tidepools are well-known for their quality and are preferred by both locals and visiting tourists over nearby tidepools where harvesting is allowed or limitations are not enforced.”

The poaching impacts of visitation are limited by park management strategies, including the presence of education and enforcement volunteers. A Tidepool Protection, Education, and Restoration Program was established whereby volunteers explain the natural components of tidepools, how to enjoy them without harming them, and ongoing research programs.

As a result of research findings, a no-access area was established in 1996 that serves to protect existing populations as a source of organisms to adjacent areas and as an undisturbed control for many studies. Two visitor surveys were conducted by an outdoor recreation policy class at San Diego State University in 1997 and 2001. These indicated strong support (99%) by the public, who “approve of closing part of the tidepools to allow it to recover.”



Giant owl limpet, Cabrillo National Monument

Although Cabrillo National Monument administers only a small part of the southern California coastline, it plays an important role for its wildlife, visitors, and the region. It is an enclave of protection for limpets and many other invertebrates from the rapid pace of urbanization in the region. The offspring of the protected Cabrillo populations will spill over park boundaries through ocean currents to enhance other populations in the region. The park’s approaches and policies help ensure that the tidepools of Cabrillo will continue to provide protection to the resource, increased marine populations in the region, and meaningful visitor experiences for future generations. ■

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Dr. David Cole a pioneer in the field of recreation ecology research



David Cole, a research biologist stationed at the Aldo Leopold Wilderness Research Institute in Missoula, Montana, has received the 2002 Director’s Award for Natural Resources Research. He is employed by the USDA Forest Service but his research in recreation ecology transcends agency boundaries and is particularly important to National Park Service managers because it provides them with a framework for dealing with recre-

ational carrying capacity issues. Dave brings a scientific mindset to the problem of balancing visitor use with minimal damage to the environment and emphasizes the importance of formally defining problems and setting quantifiable objectives. One of his major research efforts is to understand the relationship between amount of use and amount of impact in different ecosystems. His studies indicate that in many situations “relatively low levels of use cause near-maximum impact, so as use increases, impact does not increase very much.” This has major implications, for example, for the appropriateness of campsite policies. Furthermore, he has shown that where low levels of use have caused impact, existing impacts are often extremely slow to recover even if use is greatly reduced.

“His research in recreation ecology transcends agency boundaries.”

Through publications, presentations, and workshops David has assisted wilderness managers in developing policy in light of scientific research. His contribution to the Leave No Trace program was to refine practices by basing them on such research. For example, visitors had been urged not to walk in meadows because meadow was thought to be more fragile than forest. Dave’s research found that although damage to meadows is more unsightly than impacts in the forest, meadows are actually more resistant than forest ecologies.

Dave started out as a geographer. His dissertation was about wilderness vegetation and he decided to focus on the impact of humans on wilderness. He says, “Nobody else had made a career of that subject, so that’s given me lots of opportunities.” ■

Invertebrate biodiversity in hemlock forest studied

By Betsie Blumberg

AT SHENANDOAH NATIONAL PARK (Virginia), stands of hemlock forest are distinctive habitat for many species of invertebrates. Unfortunately the hemlock forests at the park and throughout the mid-Atlantic are threatened by an exotic insect pest, the hemlock wooly adelgid (*Adeleges tsugae*). To assess the invertebrate biodiversity of hemlock forests, a study was undertaken at the park by a multidisciplinary team of researchers from the Pennsylvania State University. Specimens were collected in August 1997 at two forest stands: Limberlost, a hemlock forest, and, for comparison, Mathews Arm, a hardwood forest. The specimens were identified and prepared at the Frost Entomological Museum at the Pennsylvania State University and the project report, "Biodiversity Associated with Eastern Hemlock Forests: Assessment and Classification of Invertebrate Biodiversity," was completed this year.

This study of 13,169 invertebrate specimens produced new records and documented 10 species that are potentially new to science. The discovery of new species was anticipated because scientists believe that less than 50% of North American insect and arachnid species are known. Findings in the two stands were compared using biodiversity profiles and guild analysis (sorting species based on feeding behavior). The study revealed that several orders of invertebrates contained families and species that seem to be unique to hemlock forests.

The report produced a number of management recommendations for future research. Among them was an emphasis on the importance of developing biodiversity inventories for specific habitats and



The white, cottony material on the back of this hemlock twig (top) reveals an infestation of the hemlock wooly adelgid and foretells destruction of hemlock forests at Shenandoah National Park (bottom). A recent survey of invertebrates indicates that not only are the hemlocks threatened but so are many species that occupy the special habitat they create.



"This study of 13,169 invertebrate specimens produced new records and documented 10 species that are potentially new to science."

ecosystems before the outbreak of a stressor such as the hemlock wooly adelgid. Because a stressor of this type can change the structure of an ecosystem and affect biodiversity, inventories conducted after the infestation can indicate the process of biodiversity turnover and measure the impact of the infestation.

Understanding the biodiversity of the hemlock forest habitat yields insight into the devastation resulting from the hemlock wooly adelgid infestation; with the loss of the trees comes the loss of the special ecosystem they foster. ■

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NPSFACT

The National Park Service began tracking the number of new scientific research and collecting permits issued annually throughout the National Park System in 2001 when 2,231 such permits were issued.* This number increased to 2,367 in calendar year 2002 and 2,501 in 2003.

**Permits are required for scientific research activities that involve natural resource or social science fieldwork and specimen collecting of biological, geological, and paleontological resources. Activities such as birding and noncommercial photography are not regulated by permit; some official research and collecting conducted by NPS staff require a permit. Other permit procedures apply to scientific activities pertaining solely to cultural resources.*

Virgin Islands monuments move forward

By Cliff McCreedy

ON FEBRUARY 27, 2003, Secretary of the Interior Gale A. Norton announced that regulations to protect the new Virgin Islands Coral Reef National Monument and the expanded Buck Island Reef National Monument will go forward. Her statement at the U.S. Coral Reef Task Force meeting in Washington, D.C., marked a critical change in management and protection of coral reefs in the Virgin Islands parks. The new monuments were created in 2001 to restore these coral reef ecosystems and replenish fish and shellfish populations. Designed to be managed as fully protected marine reserves, the monuments finally became effective with Secretary Norton's announcement and promulgation of regulations in May 2003.

“Years of tenacious scientific work and careful legal and policy research culminated in the long-overdue realization of these promising new reserves.”

“The conservation of our coral reefs is a high priority at the Interior Department,” Secretary Norton said. “These ‘rain forests of the sea’ are not only breathtaking but they are also storehouses of immense biological wealth. We will be protecting them against damage by careless boat anchoring and all extractive uses except some traditional fishing.”

The new 12,708-acre (5,147-ha) Virgin Islands Coral Reef National Monument was established to increase protection of marine resources located near the Virgin Islands National Park on St. John, while the Buck Island Reef National Monument on St. Croix was expanded from 880 acres (356 ha) to more than 19,000 acres (7,695 ha). The Buck Island expansion area includes additional coral reefs (patch, spur and groove, deep and wall) and the unusual “haystacks” of elkhorn coral that support endangered sea turtles and a high diversity of marine life and that attract tour boats to the snorkel trail. The Virgin Islands Coral Reef National Monument has both bank and spur-and-groove reef formations, mangrove shorelines, hardbottom habitat, and seagrass beds. Recreational boating, snorkeling, and scuba-diving are encouraged, but anchoring requires a permit at Buck Island Reef and is not allowed at Virgin Islands Coral Reef National Monument. Fishing for blue runner and baitfish in limited portions of Virgin Islands Coral Reef National Monument is the only form of fishing allowed.

Years of tenacious scientific work and careful legal and policy research culminated in the long-overdue realization of these promising

Massive branches characterize elkhorn coral (*Acropora palmata*), an ecologically important marine species in national parks of the Caribbean Sea. Created in 2001, the new Virgin Islands Coral Reef National Monument and the expanded Buck Island Reef National Monument will help restore coral reef ecosystems and replenish fish and shellfish populations.



National park research engages future scientists participating in *JASON XIV: From Shore to Sea*

By Yvonne Menard

new reserves. That fish, lobster, and conch populations had diminished to alarming levels was not in doubt. Studies by park staff and U.S. Geological Survey (USGS) scientists had contributed greatly to understanding how fishery resources and reef fish assemblages had declined dramatically from overfishing, illegal harvest, and ongoing mortality from discarded fish nets and traps. Two recent joint studies by Dr. Caroline Rogers of the USGS and Dr. Jim Beets of Jacksonville University identified low biomass and low numbers of species and individuals of finfish and shellfish. Ironically, Rogers and Beets reached the conclusion that species composition and numbers of fish, lobsters, and conch are no greater inside Virgin Islands National Park, where one would expect greater species protection, than outside park boundaries.

Scientific collaborations and interagency partnerships will continue to be critically important to park managers in evaluating the efficacy and performance of the recently created reserves. For example, Buck Island Reef and scientists with the National Oceanic and Atmospheric Administration's (NOAA) National Center for Coastal and Ocean Science Biogeography Program have been collaborating since January 1999 to map and document benthic habitats and marine species in the existing and expanded Buck Island Reef area. They will intensify their work, using a NOAA research vessel (March 2004), equipment, and scientists, with additional funding from the NPS Natural Resource Preservation Program beginning in FY 2005. Virgin Islands Coral Reef National Monument plans similar surveys of fish and invertebrate populations. These efforts will evaluate coral health, document previously harvested species of fish and marine invertebrates, and shed light on their possible recovery in the reserves.

All the Virgin Islands parks are highly popular destinations for tourists to enjoy beautiful landscapes above and below water. Each is developing general management plans (GMPs) beginning in 2004. Development of GMPs and outreach and education will be critical to designing the shared future of these parks in collaboration with fishers, local communities, the tourism industry, and the Virgin Islands territorial government. ■

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STUDENTS FROM AROUND THE WORLD went on a virtual science expedition to the California Channel Islands in 2003 with world-renowned oceanographer and explorer Dr. Robert Ballard. Known as *JASON XIV: From Shore to Sea*, the year-long study adventure highlighted research and science at Channel Islands National Park and National Marine Sanctuary, and more than 1.6 million middle and elementary school students and 35,000 teachers participated.

Ballard started the JASON Project in 1989 after receiving more than 16,000 requests from students who asked to go with him on his next expedition following the RMS *Titanic* discovery. The JASON Project, designed to engage students in science and technology, has been proven to motivate them to take a greater interest in scientific careers. Its multimedia components include a standards-based curriculum, interactive live satellite broadcasts, hands-on field research, professional development for teachers, classroom exercises, and an award-winning website.

During *JASON XIV*, students used cutting-edge technology to discover the marine and terrestrial ecosystems, geology, archeology, and cultural history of the Channel Islands. The national park became a living laboratory, a setting to stimulate young minds, a place to engage in research.

Students from around the globe interacted via a two-way satellite link with researchers on Anacapa Island and at the Santa Barbara Maritime Museum. During two weeks in December and January they participated in more than 55 live satellite broadcasts, at least one of which was aired daily on the National Geographic Channel. Through the broadcasts students in the classroom had the opportunity to monitor urchins in the kelp forest, study a recovering island ecosystem, and immerse in the traditions of the native Chumash.



Addressing JASON Argonauts worldwide, guest researcher Jean-Michel Cousteau recounts the technological advances in diving equipment that have allowed scientists to gain a better understanding of ocean resources and direct conservation efforts.

natural resource education



Broadcasting live, *JASON XIV* host and oceanographer Dr. Robert Ballard and his Argonaut cohort (top) facilitate interaction of students around the world and researchers in the field at Channel Islands National Park and the Santa Barbara Maritime Museum. During a two-week period, the *JASON* Argonauts, alongside researchers, explored underwater kelp forests at the park, immersed in native Chumash culture, reviewed the history of diving, and applied remote sensing tools to ecological monitoring on Anacapa Island.

Designed to engage students in science and technology, the *JASON* Project modeled its field activities in 2002/2003 after actual resource monitoring being conducted at Channel Islands National Park. In one exercise Argonauts (above) compared real-time ocean temperature data relayed from a radio-controlled NASA airplane with those collected by divers at the park and satellites. Rich in biodiversity, kelp forests thrive in cool water and are monitored at the national park.

Assisting Dr. Ballard, a select group of students, teachers, and researchers hosted the broadcast via satellite and the Internet. Alongside researchers, these student Argonauts answered questions on Web chats and posted daily journals. They were the first to test a brand-new Uninhabited Aerial Vehicle (UAV), created for the *JASON* Project by NASA's Goddard Space Flight Center. The Argonauts compared and analyzed data collected by the UAV, space satellites, and underwater instruments. The UAVs were outfitted with a thermo-infrared imager, which measured heat output and translated it into black and white images, allowing students to detect changes in sea surface temperatures or survey the kelp beds and sea lion rookeries.

Alongside national park marine biologist David Kushner, students monitored the health of subtidal species and debated the reasons for establishing marine reserves. Stimulated by the efforts of park terrestrial biologist Tim Coonan to save the endangered island fox, teams of students used a Web-based ecology simulation game to develop their own fox recovery plan.

This project was created and supported by a phenomenal partnership among the *JASON* Foundation for Education, Channel Islands National Park and National Marine Sanctuary, NASA, the Santa Barbara Maritime and Natural History Museums, the University of California, and Ventura and Santa Barbara County schools. A National Park Foundation grant sponsored more than 70 local teachers and their students, providing them with the *JASON* curriculum. These local schools continue to develop innovative ways to use the content-rich *JASON XIV* curriculum. The *JASON* Project has become the backbone of one school's Gifted and Talented Education program. Another school offers *JASON XIV* as an elective science course. An evaluation conducted by the Educational Development Center for Children and Technology found that the teaching methods used by the *JASON* Project increased students' abilities to understand scientific concepts and manipulate data, improving critical thinking and communication skills.

“Students in the classroom had the opportunity to monitor urchins in the kelp forest, study a recovering island ecosystem, and immerse in the traditions of the native Chumash.”

The national park environment gave these budding scientists a chance to step out of the classroom and into an outdoor lab, an opportunity to explore the natural world. In the words of Tano Cabugos, a 13-year-old Argonaut of Chumash descent, “I want to help the ocean, and the more I can learn ... the better I can help.” After scuba-diving in the island kelp forest, Tano said, “Everything is so alive and every movement you make affects everything around you. Since I was four, I wanted to be a marine biologist. That dive was just incredible. Underwater, I felt like I was in outer space, just so aware of my body and the whole world around me. I can't wait to get down there and explore.” ■

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Distance learning and a prescribed burn at Homestead National Monument of America

By Amy Garrett

LONG-DISTANCE PHONE CALLS used to be the next best thing to being there. In 2003, long-distance learning technology created an experience just like being there. For example, students from two Nebraska high schools connected with on-site professionals at Homestead National Monument of America in Beatrice, Nebraska, during the annual prairie burn in May 2003. The real-time, curriculum-based education program at Homestead is a model for how distance learning can be integrated into a park's interpretation and education programs.

As the prescribed fire burned in the background, students conversed with wildland firefighter and natural resource management specialist Jesse Bolli as he discussed fire ecology, the tools of wildland firefighting, and the beneficial effects of fire on the tallgrass prairie. Interacting with knowledgeable professionals on the scene, like Bolli and Jim Loach, associate regional director of the Midwest Regional Office, makes this distance-learning experience exceptionally rewarding for students. As events unfold on the prairie, students ask questions that stimulate discussion. This method—made possible through a partnership with the Southeast Nebraska Distance Learning Consortium and Educational Services Unit 5—provides a learning opportunity for students that they otherwise would not have.

"Students and NPS staffs were part of the action but in the safety and convenience of their classrooms and offices."

The monument maintains a four-year, prescribed-burn cycle that simulates the historical fire regime. Each year a third of the tallgrass prairie is burned on a rotational basis; every fourth year no burn is ignited. Historically, lightning strikes have started fires on the tallgrass prairie, and Native Americans introduced fire to bring bison herds back to graze on grass. They also used fire in warfare and protected their villages by burning firebreaks around them.

During the burn, students were afforded panoramic views of the prairie via the distance-learning cart, which is equipped with a computer and cameras. The cart is connected to a power source and fiber optics. The power and fiber-optic connections are hidden under four artificial boulders located around the visitor center. For the last couple of years park and public educators have used this distance-learning program to explore various uses of the equipment to better serve students and to support required educational standards. Moreover, through NPS Parks As Classrooms grants, the monument has acquired additional tools for use with the new distance-learning technology. For example, calculator-based labs, graphing calculators, and global positioning systems enhance resource-based learning



Amy Garrett, education coordinator for Homestead National Monument of America, controls the operation of the distance-learning cart while Jim Loach, associate regional director, and Jesse Bolli, firefighter and resource manager, discuss the prescribed burn and answer students' questions. Garrett exclaimed, "We're only limited by our imaginations on how we use this technology."



Students remotely viewed firefighters using hoses and drip torches during the annual prairie burn at Homestead. Long-distance technology is an "exciting tool," remarked Mark Engler, superintendent of the national monument. "Many times people like to get into the thick of the action. This allows students to experience that while in the safety of their classrooms."

activities. In addition to prescribed burns, these tools are used to monitor water quality, track erosion of the monument's Cub Creek, and explore tallgrass prairie biota such as insects and animals.

While students interacted through distance-learning technology, Midwest Region staff members saw the event take place over the Internet via video-streaming equipment. Those viewing the burn over the Internet were not able to interact with the rangers, but they witnessed the prescribed burn in real time. Hence, students and NPS staffs were part of the action but in the safety and convenience of their classrooms and offices. ■

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Improving the “Geology Talk”

By Jim F. Wood

NATIONAL PARKS house the icons of America’s geologic heritage, comprising what is arguably the world’s greatest educational rock collection, but geology can be a difficult subject to present to the public. In March 2003 a two-day workshop was held at the National Science Teachers Association conference in Philadelphia to help participants from 25 parks and several central offices improve their skills and knowledge in communicating geologic stories and issues.

The topics covered in the workshop included planning for natural resource issue interpretation, making geology relevant, using geologic themes, the nature of science, and controversial issues in geoscience. All workshop participants shared examples of projects from their parks and several invited speakers gave special presentations.

Bob Lillie, National Park Service seasonal interpreter and professor at Oregon State University, gave an overview of national park geology using regional geologic setting and modern landform analogies to make park geology more understandable. Phil Zichterman, chief of interpretation, education, and technology at Curecanti

“Geology can be a difficult subject to present to the public.”

National Recreation Area, demonstrated new low-cost technology that parks can use to create quality video for educational projects on the Web or on a DVD player. Allyson Mathis, interpreter at Grand Canyon National Park, presented a suite of interpretive techniques for geology programs and led discussions on the nature of science and controversial issues for frontline interpreters.

Workshop participants also learned about “Views of the National Parks” from Dave Krueger, information technology specialist with the Natural Resource Information Division. An interactive, educational computer application, Views presents general information and scientific principles on Web pages and CD-ROMs (see www2.nature.nps.gov/synthesis/views). Geology-related themes designed in the past year include volcanism, glaciers, paleontology, and coastal geology. Thematic geology modules prepared in Views become building blocks that any park can use as a starting point to tell its own unique geologic story.

Views takes the user to a park through multimedia presentations and interactive educational units that help to ensure that park programs reach a greater number of people, including those who are unable to visit park sites or attend a ranger-led program. Geology-related virtual experiences have been prepared for Pu’uhonua o Honaunau National Historic Park (Hawaii) and Timpanogos Cave National Monument (Utah). Several others are being prepared, including Florissant Fossil Beds (Colorado) fossil mysteries, Grand

Canyon (Arizona) river-to-rim geology, and geology on the National Mall (Washington, D.C.).

A core concept for the workshop was the four-step method for planning and evaluating natural resource issue interpretation, as described in the 1995 National Park Service report “Interpreting Critical Natural Resource Issues in Canadian and United States National Park Service Areas.” These steps include identifying the issue, determining the message, targeting the message, and determining techniques. Report author Mike Whatley, chief of the Natural Resource Information Services Branch, led the group in activities using the four-step method to evaluate existing programs and frame new proposals.



Interpreting geology to national park audiences is a specialized skill. In March, NPS staff participated in a two-day workshop to improve their abilities and knowledge in communicating geologic stories and issues.

By conducting the workshop in conjunction with the National Science Teachers Association conference, National Park Service interpreters had the opportunity to attend the larger meeting, exposing them to a number of useful educational techniques, inexpensive sources and supplies, and a network of teacher contacts.

The Geologic Resources Division, the Natural Resource Information Division, and workshop presenters are developing a manual on communicating geologic stories and an issues handbook to deliver the information to those who could not attend the workshop. The Natural Resource Information Division also plans to use the geology workshop as a model for future workshops on natural resource topics. ■

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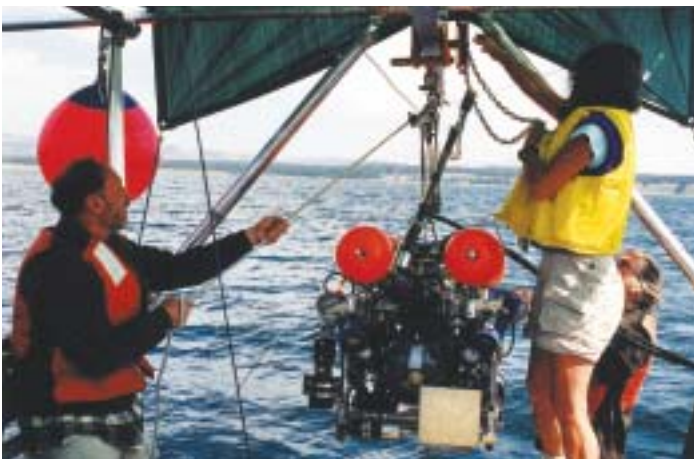
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New discoveries on Yellowstone Lake's floor

By Alice Wondrak Biel with Lisa Morgan

BELOW THE WATERS of Yellowstone Lake (Wyoming), researchers have identified a spectrum of fascinating geologic features. The five-year (1999–2003) cooperative effort between the U.S. Geological Survey (USGS) and the National Park Service has resulted in a high-resolution map of the floor of Yellowstone Lake, revealing many features not recognized in previous lower-resolution maps.

Using high-resolution multibeam swath sonar imaging, seismic reflection sub-bottom profiling, and a submersible remotely operated vehicle, researchers discovered submerged faults, explosion craters, domal features, siliceous spires, hydrothermal vents, submerged paleo-shorelines, and slumped structures. Also found were rhyolitic lava flows that extend far out into the lake that are believed to be a key to controlling many morphologic and hydrothermal features in the northern two-thirds of the lake. The team produced the first geologic map of Yellowstone Lake that accurately depicts the Yellowstone caldera boundary where it passes through the lake. In short, where relief maps of the park once showed Yellowstone Lake simply as a flat blue spot in the middle of detailed topographic features, now the lake is seen as a multifeatured, topographic space. Moreover, results are providing insight into the extent of post-caldera-collapse volcanism, glaciation, active hydrothermal processes, and potential geologic hazards.



Dave Lovalvo (left), of Eastern Oceanics, along with Lisa Morgan (center) and Pat Shanks (right) of the USGS, launches a remotely operated vehicle (ROV) into Yellowstone Lake. The ROV allows direct observation and sampling of features identified in the bathymetric surveys of the lake floor.

In 2003 the research team, composed of members from the USGS and Eastern Oceanics, collected seismic reflection profiles in the Southeast, South, and Flat Mountain Arms and other areas of the lake, including hydrothermal areas. Unlike multibeam swath sonar imaging, which maps the surface of the lake floor, seismic reflection profiling penetrated the lake floor to about 80 feet (25 m), giving researchers detailed information about the physical character of the subsurface. Using a submersible, the team spent an additional five days

photographing lake-floor features and sampling vent fluids and solids. The research team, joined by scientists from the University of Minnesota, also deployed a newly developed, in situ chemical sensor capable of measuring pH, temperature, and concentrations of hydrogen sulfide and hydrogen. The sensor provides information in real time about short-term variations in the composition of hydrothermal vent fluids.

“Results are providing insight into the extent of post-caldera-collapse volcanism, glaciation, active hydrothermal processes, and potential geologic hazards.”

Park wildlife managers also are benefiting from these revolutionary mapping efforts. In summer 2003, research focused on areas known to be spawning habitat for nonnative, fish-eating lake trout. By understanding the seismic character of these areas, park managers hope that unknown spawning sites for this aggressive species will be identified, enabling fisheries scientists to better manage lake resources. Additionally, researchers have investigated hydrothermal vent fluids on the lake floor and the possible transmission of potentially toxic trace metals, including mercury, antimony, arsenic, and thallium, from vent fluids up through the food chain to native Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) and animals that feed on them. Examination of the mercury content of some fish revealed slightly higher concentrations than for most fish in western lakes. In addition, hair samples collected by the Interagency Grizzly Bear Study Team from two bears living near the lake showed elevated levels of mercury, whereas two bears elsewhere in the park did not. Moreover, cutthroat trout frequent shallow hydrothermal vent areas in the lake, sometimes called “trout jacuzzis.” Hence, a picture of geochemistry and its effects on the ecosystem in Yellowstone is emerging.

The lake-mapping effort was one of eight interdisciplinary tasks that USGS scientists recently completed under the Integrated Geoscience Studies of the Greater Yellowstone Area Project. An 18-chapter USGS professional paper and maps summarizing the findings from this work are in press. Available publications are listed at <http://minerals.cr.usgs.gov/projects/yellowstone/products.html#task7>. ■

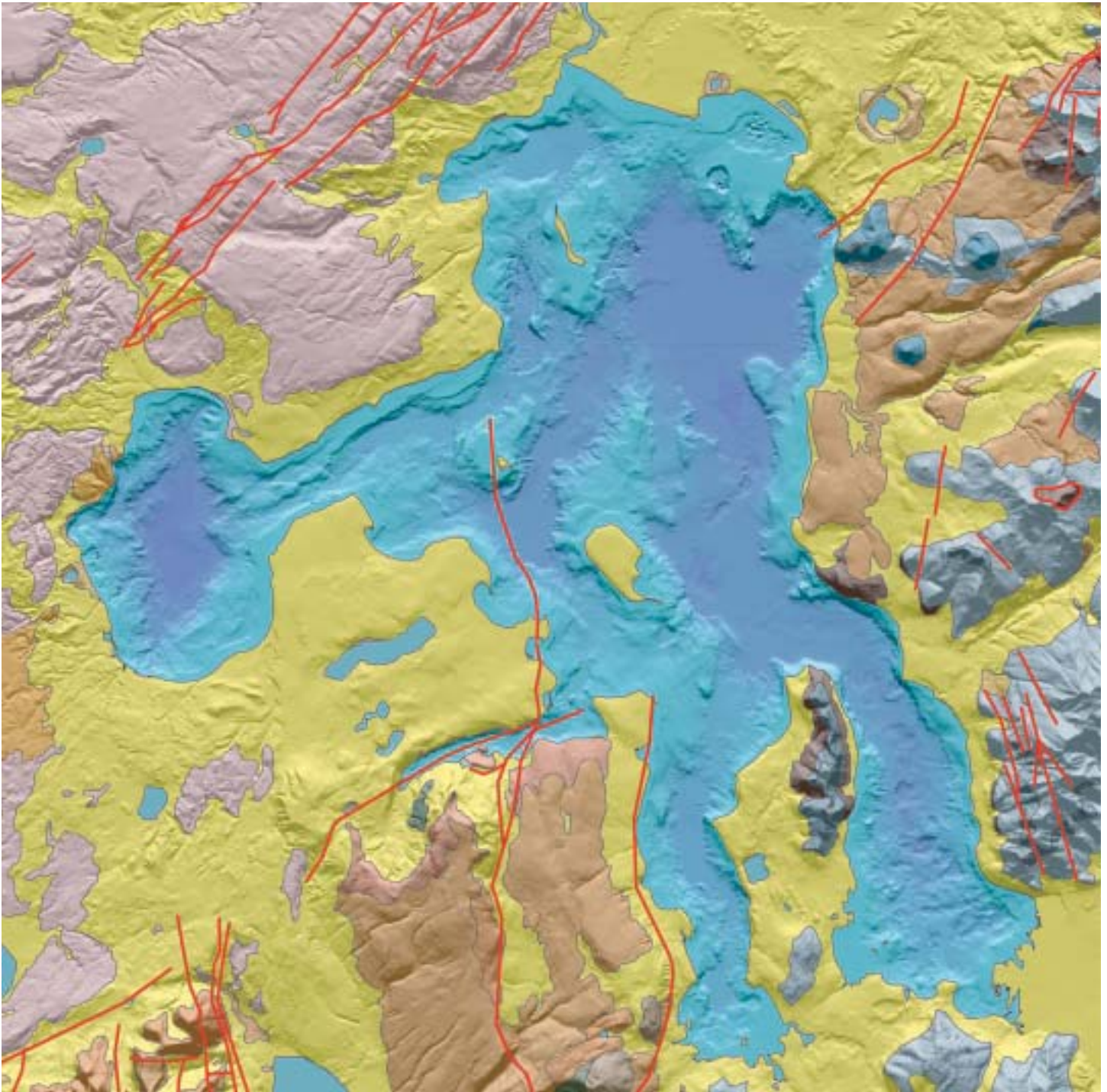
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HIGH-RESOLUTION BATHYMETRIC RELIEF MAP OF YELLOWSTONE LAKE



This high-resolution bathymetric relief map of Yellowstone Lake (blue areas), acquired by multibeam sonar surveying, depicts hydrothermal vents, faults, explosion craters, and many other features. Researchers from the USGS, in

partnership with the National Park Service, discovered the features while mapping the lake floor over the past five years. The colorful shapes surrounding the lake represent different geologic units. Red lines are faults.

Preventing Natural Resource Impairment

“Humans have achieved mastery over most of the earth’s surface. With this mastery has come an acute awareness ... that the land will not sustain humans unless humans sustain the land.”

—William L. Halvorson
National Parks and Protected Areas: Their Role in Environmental Protection

The National Park Service is responsible for ensuring that the resources of the National Park System are passed on “unimpaired” for the enjoyment of future generations. Park management decisions are predicated on the test that actions will not impair resources or the values associated with them. Nevertheless, the role of the National Park Service as caretaker of the nation’s extraordinary heritage is increasingly challenging given the wide variety of influences that affect park resources, many of which arise outside park boundaries and result from complex environmental, social, political, and economic factors. As the articles in this chapter illustrate, maintaining the health of park resources requires vigilance. It also involves the courage to lead a debate on what is necessary to preserve park resources. It takes skill to marshal scientific investigation to inform park managers and the public about a threat. And it demands patience to effect resolution. Finally, park preservation is impossible without diligence, expertise, strong partnerships, and public support. At stake is the National Park Service’s “contract with the future”—the perpetuation of a park system that is the collective expression of America’s superlative heritage.



Sustainer of life in the Chihuahuan Desert, the Rio Grande stopped flowing in May 2003 before the start of seasonal rains. This extremely rare event is heightening concerns for the ecological health of the river ecosystem in Big Bend National Park and the Rio Grande Wild and Scenic River, which has been in decline for decades.

Big Bend's Rio Grande faces uncertain future

By Raymond Skiles and Jeff Bennett

REGIONAL AND EVEN NATIONAL media attention briefly turned to the Rio Grande in Big Bend National Park in May 2003. The river, once a mighty regional and international resource, simply stopped flowing. For a few weeks before seasonal rains began, portions of the river became only pools isolated between sun-bleached gravel beds. Historical records indicate the river stopped during droughts of the past, most recently in the 1950s. But the May event brought to light the more disturbing long-term decline of the Rio Grande ecosystem. Dams, diversions, industrial and agricultural contamination, and the invasion of exotic species are killing this river.

Dams and diversions have stopped the natural flooding that occasionally scoured banks and realigned the channel. Without regular floods the river channel grows narrower and deeper. Cobble bars that were once productive habitat for fish and invertebrates have become choked with silt and no longer support these organisms. Sustained low flow reduces dissolved oxygen, concentrates contaminants, and favors exotic species over natives that are adapted to flow variability.

The Rio Grande was once home to 38 native fish species. Two are now extinct, one is federally endangered, and nine are no longer found in the Big Bend portion of the river. Eight exotic fish species compete with natives; nine of the remaining native fish species are at risk. Nutria,



Mariscal Canyon, start of the Rio Grande Wild and Scenic River designation in Big Bend National Park, was reduced to pools of water isolated by sun-bleached gravel beds in May. The flow stoppage highlights the effects of drought, to be sure, but also the effects of dams and diversions; agricultural, urban, and industrial contamination; and exotic species invasion. Park staff has little influence to slow the degradation of river resources.

“The National Park Service and partner agencies are gathering information needed to demonstrate the relationship between river changes and resource damage.”

large South American rodents that prefer calm water, are abundant in the river. These voracious herbivores have stripped aquatic vegetation from the river and adjacent spring-fed pools that are the only habitat of endangered Big Bend mosquitofish. The elegant slider, an exotic turtle species that is suited to slow-moving water, now hybridizes with the native Big Bend slider, a species adapted to the more frequent historical flooding of the Rio Grande. Of at least five native mussels, only dead shells of three have been found in recent years.

Native plants such as cottonwood and willow are now rare. Exotic giant reed, tamarisk, bermuda grass, and other nonnatives dominate the banks. The presence of pesticides, fertilizer, and urban waste has led to warnings for humans to avoid contact with the water and consume fish only in moderation.

Though the Rio Grande is a significant resource in Big Bend National Park and is the primary resource in the Rio Grande Wild and Scenic River, park managers currently have little influence to halt or slow ongoing degradation. Water law does not allow for in-stream flow rights, while competition for regional water sources is increasing. Regardless, the National Park Service and partner agencies are gather-

ing information needed to demonstrate the relationship between river changes and resource damage. These partnerships and recent NPS initiatives such as the Natural Resource Challenge have resulted in baseline assessments of channel characteristics, water quality, flow cycles, and species inventory, but essential information is still missing. What are the requirements for minimum flow, water quality, and channel conditions that will sustain species now declining or favor natives over exotics? Where will local springs and tributaries provide enough water to attempt restorations? And most significantly, how can park managers help to reverse the effects of decades of decline?

Historical trends leave little room for optimism about the Rio Grande's future. Will the river be reduced to pretty scenery on the surface and waste transport below? Or can its ecological integrity be rescued? Only a combination of societal values that create policy and legal opportunities, and sound science that demonstrates resource needs, will provide real opportunities to improve the Rio Grande. ■

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Interagency cooperation and science keep the Buffalo River system free-flowing

By Faron Usrey

BUFFALO NATIONAL RIVER (Arkansas) provides a case study of how NPS science and monitoring played a role in the decision-making process to revoke a permit for a dam that would have affected park resources. The story begins in 1996 when a regional water district performed a water-supply analysis that recommended building a reservoir on Bear Creek—a large tributary to the mid-reaches of the Buffalo River—to meet the growing need for water in the area. Established in 1972 as the country's first national river, Buffalo National River is in a watershed of which about 61% is privately owned. Approximately 11% of the watershed is contained within the boundaries of the national river, and 28% is managed by other federal and state land management agencies. Local authorities applied for and received a permit from the U.S. Army Corps of Engineers (the Corps) to build a dam on Bear Creek. The Corps issued an environmental assessment (EA), which was open for public review under the National Environmental Policy Act (NEPA).

To understand the effects of the proposed impoundment on the river's flow and biota and to meet a public obligation under NEPA, park managers joined a multiagency effort with the U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service, University of Arkansas, and independent natural resource professionals to ascertain quantifiable impacts on the river system. In 2002, USGS hydrologists determined that during times of low flow (August through October), as much as 25% of the flow below the Buffalo River's confluence with Bear Creek

“Being able to quantify ecosystem requirements of the river's flow with valid scientific results was critical in the decision [to keep Bear Creek free-flowing].”

originates from Bear Creek. Concerns about the aquatic community's dependence on the creek's flow at these times generated several investigations. In 2002, after eight national and local environmental groups filed suit against the Corps, the permit approving the damming of Bear Creek was officially revoked. The Corps has agreed to hold any future water development permit decisions in abeyance until the National Park Service has made a Determination of Effect as required under Buffalo National River's enabling legislation.

Monitoring results on the Buffalo River in Arkansas over a 10-year period prior to the EA strengthened arguments for further watershed protection by natural resource agencies through targeted conservation programs that stress the reduction of agricultural runoff. Monitoring results showed a decline in water quality on certain reaches of the river. This decline was the basis for cooperative studies among Buffalo National River, state agencies, the USGS, and local universities.



Although untamed rivers are part of our cultural and natural heritage, virtually every river in the lower 48 states is now regulated by dams, locks, or diversions. The Buffalo River is one of the few remaining free-flowing rivers, offering both swift-running and placid stretches. Recently, staff diligence and science kept a main tributary, Bear Creek, on Buffalo River free-flowing.

Researchers, who examined the effects of human activities and changes in land use on the river's natural resources, documented degradation. They reported that land-use changes, in particular the conversion of forest to permanent pasture, negatively impact the river's water quality, in-stream habitat, geomorphic structure, and aquatic communities. Funding from local universities and state and federal agencies—with the largest portion of the federal funding originating from the NPS Water Resources Division and the Natural Resource Preservation Program—covered the costs associated with these highly beneficial and timely scientific studies.

National Park Service science, vigilance, and cooperation with other agencies kept Bear Creek free-flowing. Being able to quantify ecosystem requirements of the river's flow with valid scientific results was critical in the decision. Because park managers at Buffalo National River were aware of community activities in the watershed and had been actively monitoring the river, park resources were preserved and the park's legal standing was strengthened. ■

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Wind farms: An emerging dilemma for East Coast national parks

By Betsie Blumberg

LAND-BASED WIND FARMS have been providing clean energy in the United States for some time, but although Europe harnesses offshore wind, to date there are no offshore wind farms in the United States. Recently, however, several proposals for offshore wind farms have been submitted to federal and state regulatory agencies. These are to be located along the Atlantic Coast where ideal conditions exist: strong winds, relatively shallow water, and a large human population in need of electricity. National parks along the East Coast face the dilemma of welcoming a renewable, nonpolluting energy source and at the same time protecting park resources from environmental impacts not yet fully understood.



This view of the sea from Cape Cod National Seashore would change if a proposed wind farm were built offshore. The Atlantic Coast provides ideal conditions for the operation of offshore wind power plants, but their impact on natural resources is not yet understood.

The sheer magnitude of these power plants arouses concern. Wind farms are very big—they may cover an area of 25 square miles (65 sq km) with 150 wind turbines that are 400 feet (122 m) tall. The pylons supporting the turbine towers are sunk 30 to 50 feet (9 to 15 m) into the ocean floor. The towers are lighted to be visible to boats and aircraft. The turbines produce a low level of noise.

Companies that produce wind power have posted notice of intent, or have submitted formal proposals, to construct offshore wind farms in the waters of six states: Massachusetts, New York, New Jersey, Delaware, Maryland, and Virginia. These account for nine possible wind farms, although one company, Winergy, has identified 21 potential sites along the north Atlantic Coast.

The permitting process for these power plants starts when a proposal is submitted to the agency that has jurisdiction over the waters at the site. The U.S. Army Corps of Engineers holds jurisdiction in federal waters; in state waters it belongs to the state's environmental protection agency. The lead agency prepares the environmental impact statement (EIS) or other appropriate review document depending on individual state law. The cooperating agencies (all federal, state, and local agencies

involved) submit their concerns, review the final EIS or review document, and advise the lead agency of their response to it. The lead agency then decides to accept or deny the proposal. The National Park Service, as a cooperating agency, determines whether the impacts cited in the EIS are acceptable for park purposes based on law and NPS policy. If a cooperating agency opposes the lead agency's decision, it can appeal it to the appropriate state or federal court.

One park in the Northeast, the Appalachian National Scenic Trail, has already had experience with the prospect of land-based wind farms. In four states, wind farms have been proposed on the windy ridges near the trail. Advocates for the trail, the Appalachian Trail Conference, argue that where a utility is proposed, sufficient mitigation must be incorporated so that trail values, such as quality of experience and preservation of views (particularly important to protect on this scenic trail), are not degraded. In Tennessee a proposal was revised in favor of the trail, and the wind farm was built 20 miles (32 km) away. Concern is now focused on a proposal in Maine from Endless Energy Company for a wind farm that would be visible from the trail for four days of hiking.

In Massachusetts, Winergy has proposed building a wind farm near the town of Truro, just beyond the quarter-mile offshore boundary of Cape Cod National Seashore. According to Nancy Finley, chief of natural resources at the park, the proposed site for the wind farm has been designated by the state as Massachusetts Ocean Sanctuary, which likely has additional regulatory requirements. Nonetheless, the proposal raised concerns at the park about impacts in the air, in the water, and on land.

In the air, wind turbines may stand in the pathway of migratory birds, particularly the thousands of sea ducks whose route over water follows the shoreline. The scenic view would also be affected because this wind farm would be near shore and visible from the park. In the ocean, construction of the towers may disturb seafloor resources. On land the constantly shifting shoreline, which can move 30 or 40 feet (9 or 12 m) in a single storm, makes securing the transmission line very challenging. The transmission line would run underground through the park, its construction disturbing terrestrial natural resources and threatening archeological remains in its path.

Finley says that the park will work within the existing permitting process to ensure that environmental impacts are addressed. That is what each park near a proposed offshore wind farm along the Atlantic Coast will be doing as it works to accommodate this renewable energy source while protecting natural and cultural resources that may be affected. ■

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Managing energy development issues to protect park resources

By John Bunyak, John Reber, and Lisa Norby

AS PART OF THE EFFORT to improve energy independence, there has been a push to streamline the development of all energy sources—particularly oil, gas, and coal-bed methane—in the western United States. The West is home to many of the nation's parks, and increases in energy development activities both outside and along park boundaries may negatively impact the air and water quality of nearby park units. National Park Service managers are also concerned about the possible impacts of new or expanded transportation pipelines or power lines through parks. In 2003, park managers were actively involved in developing strategies to minimize the potential harm to park resources from energy development activities.

“Park managers can no longer protect the natural resources of our nation's parks without paying attention to, being informed of, and becoming actively involved in activities like energy development that are happening outside park boundaries.”

The Rocky Mountain region has been at the center of the West's energy development activities, in particular the Powder River Basin area of Montana and Wyoming. The Wyoming Powder River Basin Oil and Gas Project alone involves developing and operating approximately 39,000 new coal-bed methane wells, 3,200 oil wells, and various support facilities. The National Park Service concluded that air emissions associated with these activities could adversely impact visibility and other air quality-related values at several park units. These units include Badlands and Wind Cave National Parks, which are mandatory Class I air quality areas under the Clean Air Act. Devils Tower National Monument, Fort Laramie National Historic Site, Jewel Cave National Monument, and Mount Rushmore National Memorial, all Class II air quality areas, would also be affected.

Superintendents and natural resource staff from several of the affected parks and regional offices met with NPS Air Resources Division staff in May 2003 to discuss ways to work together to protect park resources as energy development proceeds, particularly in the Powder River Basin. Subsequently NPS staff met with representatives from the Bureau of Land Management, state agencies, tribes, and other entities to establish working groups to address the problem. The resulting air quality task group will develop a monitoring plan and an adaptive management strategy to assess and mitigate the cumulative air quality effects of coal-bed methane development.

In response to the White House energy task force and the National Energy Policy, federal and state agencies in the Rocky Mountain region were asked in late spring 2003 to form a Rocky Mountain Energy Council (RMEC). The goal of the council is to streamline energy development in Wyoming, Montana, Utah, Colorado, and New Mexico. The National Park Service is participating in the RMEC process, although there are no proposals yet for active energy development sites within park units. Park managers are participating in the process to draw attention to their concerns about possible impacts on park resources in these states. Staff from the NPS Intermountain Support Office (Divisions of Natural Resources Research and Technology, and Ranger Activities) and the Natural Resource Program Center (Air, Water, and Geologic Resources Divisions) are involved and available for assistance as the process continues.

In January 2003 the National Park Service also held its first Western Energy Summit, in Phoenix, Arizona. The summit was created to give park resource managers and superintendents the background information they need to constructively and effectively influence decisions affecting energy development on federal lands adjacent to parks and to advance sound energy-use strategies within park boundaries. The gathering included not only NPS staff but also key representatives from other federal and state agencies, such as the Environmental Protection Agency, Office of Environmental Compliance, Bonneville Power Administration, Western Governor's Association, National Renewable Energy Laboratory, and University of Denver. Rebecca Watson, assistant secretary for land and minerals management, opened the conference with a presentation on the National Energy Policy and its implications for the western United States. More detailed information about the Western Energy Summit, including handouts, maps, and fact sheets, is available on the NPS intranet at www2.nrintra.nps.gov/energysummit.

Park managers can no longer protect the natural resources of our nation's parks without paying attention to, being informed of, and becoming actively involved in activities like energy development that are happening outside park boundaries. Increasingly the National Park Service will need to focus on the big picture of energy development to be effective stewards. ■

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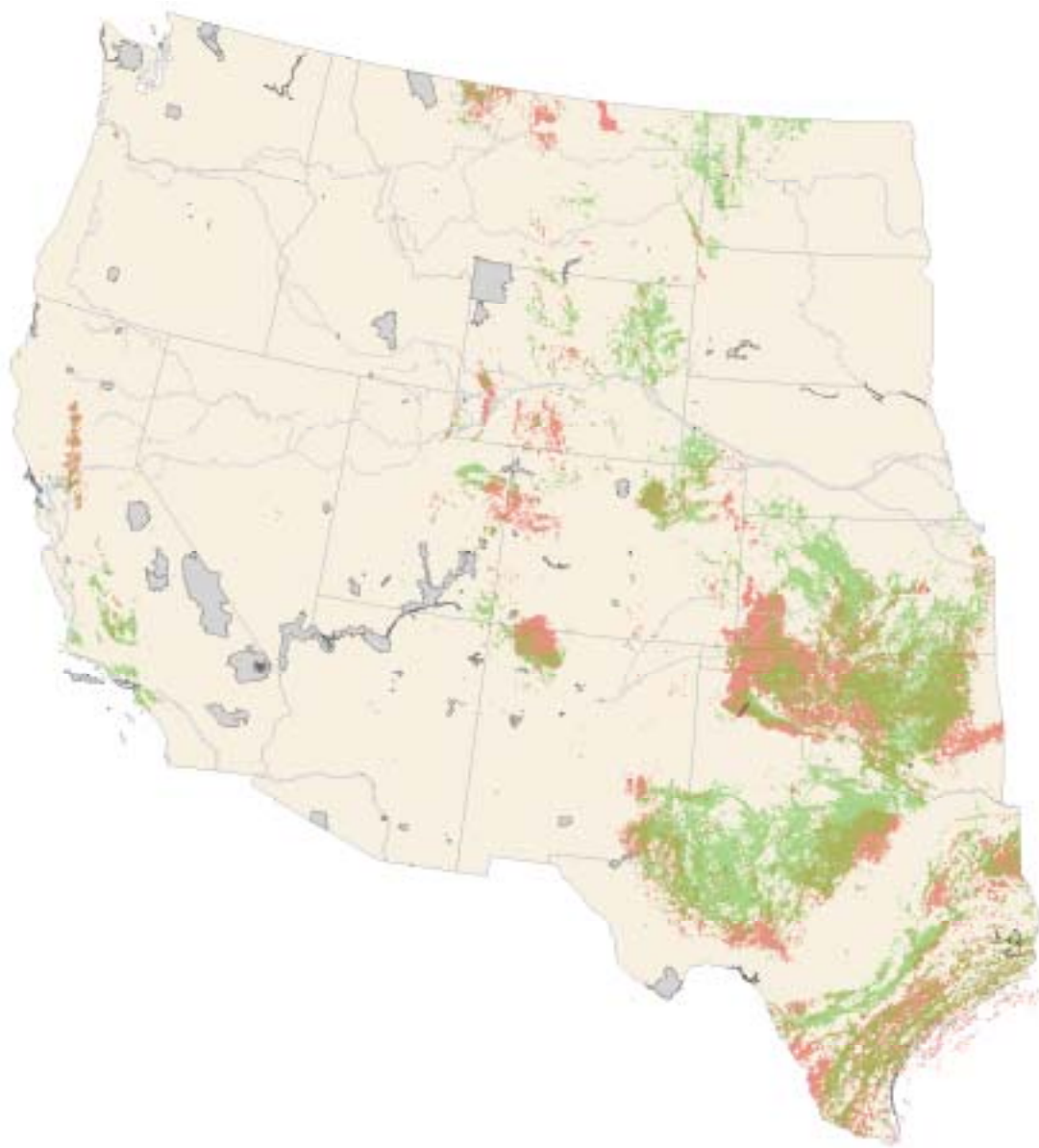
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OIL AND GAS PRODUCTION IN THE WESTERN UNITED STATES

- NPS Units
- National Trails
- Oil Production
- Gas Production



Winter sampling of snowpack in eight western parks to assess deposition of toxic compounds

By Tamara Blett

PESTICIDES AND INDUSTRIAL by-products may be leapfrogging over urban and rural areas to deposit in high-elevation ecosystems such as Rocky Mountain National Park, Colorado. Scientific studies in the Arctic have revealed that organic compounds with low vapor pressures move, in several successive stages of deposition and evaporation, toward colder areas of the biosphere, such as the poles, and upward in mountainous regions to settle in high-elevation snow. Through this “cold condensation” phenomenon, areas of some western national parks may become sinks for these compounds, known as persistent organic pollutants. In 2003, U.S. Geological Survey (USGS) researchers Don Campbell, Alisa Mast, and George Ingersoll began a three-year field sampling project to examine snowpack chemistry in Rocky Mountain National Park and seven other western and Alaskan parks to determine how much of these toxic compounds is being deposited at high-elevation and high-latitude park sites.

Air masses over the western United States may contain pollutants from sources as far away as Europe and Asia, and from local or regional sources in North America. Scientists suspect that some air masses contain persistent toxic compounds, such as pesticides like DDT, and industrial by-products like PCBs and dioxin. Snow is

efficient in removing pollutants from the atmosphere and depositing them in high-elevation terrestrial and aquatic ecosystems. Snowfall provides 50% to 90% of annual precipitation in high-elevation and high-latitude areas of the western United States. In many of these areas, seasonal snowpacks that accumulate during the fall, winter, and spring contain an integrated record of chemicals deposited during the snow season.

“Information acquired through this project will enhance scientific understanding of the global transport of airborne contaminants and their associated effects on sensitive ecosystems in western parks.”

Once deposited, persistent organic pollutants can accumulate and concentrate in food webs where they can impact reproductive success, growth, behavior, disease, and survival of animals high on the food chain, such as fish, birds, and mammals. Additionally, glacial melt and



U.S. Geological Survey scientist Don Campbell collects snow samples at Rocky Mountain National Park that will later be examined in the laboratory for toxic compounds, including mercury. The project is part of a coordinated three-year



study in eight western national parks to assess levels of contaminants that travel long distances in the air and are deposited in high-elevation and high-latitude ecosystems where they can concentrate in food webs.

snowmelt contribute to primary water sources for people residing in the mountain West and Arctic areas. Many communities obtain their drinking water almost entirely from snow and glacier meltwater. These water sources may contain airborne contaminants.

Snow is being sampled at two sites in each park for three consecutive years. These sites are located in or near two watersheds in each park selected for comprehensive water, sediment, and biological sampling. Snow samples are collected by USGS researchers with assistance from the National Park Service and other partners. Crews collect samples near the time of annual maximum snow accumulation but before the onset of spring snowmelt. Researchers dig two large snow pits and then cut a vertical column of snow from each pit. Sampling crews must use clean techniques to shovel, bag, and transport approximately 40 gallons (150 liters) of snow from each site, which will yield about 13 gallons (50 liters) of meltwater for analysis. Access to the sites is by aircraft, snowmobile, skiing, snowshoeing, hiking, or pack animals. Samples collected from each snow pit are analyzed for major ions, nutrients, dissolved organic carbon, trace metals, mercury, particulate matter, and organic contaminants.

The snow sampling project is part of the Western Airborne Contaminants Assessment Project (WACAP) to determine the risk from airborne contaminants to ecosystems and food webs in western national parks. Biological effects analysis of airborne contaminants from six ecosystem components (snow, water, sediment, lichen, bark, and fish) is being conducted in eight key parks in the West and Alaska (Rocky Mountain, Glacier, Sequoia, Olympic, Mount Rainier, Denali, Noatak, Gates of the Arctic). Contaminant concentrations in moose consumed by subsistence hunters will also be assessed in Alaska. The Environmental Protection Agency, USGS, USDA Forest Service, Oregon State University, and University of Washington are working in partnership with the National Park Service on this assessment. Information acquired through this project will enhance scientific understanding of the global transport of airborne contaminants and their associated effects on sensitive ecosystems in western parks. It will also help the National Park Service determine what actions may be needed to mitigate potential effects or protect subsistence populations. Some contaminant signals or combinations may be used to determine where the industrial by-products or pesticides originate and whether these sources are local, regional, national, or international. Contaminant deposition in the snowpack will be related to contaminant levels in air, lake water, lake sediments, plants, and fish, thereby linking ecosystem impacts to airborne contaminant pathways. ■

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Partnering to reduce risk of West Nile Virus

By Betsie Blumberg

The combined efforts of volunteers and several government agencies are reducing the risk of West Nile Virus at Allegheny Portage Railroad National Historic Site and adjacent state game land in Pennsylvania. Trash and tires had been dumped illegally on these lands over many years, creating breeding habitat for mosquitoes that may carry the disease. On two separate cleanup days in 2003, cooperating agencies eliminated these breeding grounds.



Good riddance to bad rubbish! Trucks dispose of tires abandoned at Allegheny Portage Railroad National Historic Site and adjacent state game lands, reducing breeding habitat for mosquitoes, carriers of West Nile Virus.

In June, volunteers from the local Target store worked with Pennsylvania Cleanways of Blair County, the Pennsylvania Game Commission, and the National Park Service to collect 8 tons of trash and tires from one large dump on the game land and along several miles of historic portage trace at the national historic site. The park law enforcement officer, Tom Stinedurf, coordinated the event with Dave Thomas of Pennsylvania Cleanways. That cleanup was so successful that Thomas contacted the national historic site again about three old dumps on park and game land where hundreds of tires had accumulated.

The result was a project involving six government agencies, coordinated by Stinedurf, Thomas, and Natural Resource Manager Kathy Penrod of Allegheny Portage Railroad. On the cold and rainy cleanup day in October, prisoners from the state correctional institution at Cresson did the work, heavy equipment brought in by the Pennsylvania Game Commission moved and loaded the tires and trash, and trucks and drivers from the Pennsylvania Department of Transportation and Blair County Solid Waste and Recycling hauled it away. Together they removed about 1,400 tires and 5 tons of trash.

By the end of the cleanups the dumps were gone for good. The sites are now clear and will no longer attract trash. And, most importantly, they no longer support breeding ground for potential carriers of West Nile Virus. ■

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Small Saint-Gaudens managing exotic invasives

By Betsie Blumberg



Resource Manager Steve Walasewicz releases beetles in a field of invasive, exotic purple loosestrife vegetation. The biological control is one mechanism that is helping the small northeastern park see the results from executing its Exotic Plant Management Plan.

Controlling invasive vegetation is an especially high priority at Saint-Gaudens National Historic Site in Cornish, New Hampshire. Invasive plants have the capacity to quickly overwhelm native vegetation and alter habitats in the small, 150-acre (61-ha) park. Consequently, staff are implementing the park's Exotic Plant Management Plan and making substantial progress.

The park includes the historic home, studios, and 100-year-old formal gardens of its namesake, the American sculptor Augustus Saint-Gaudens. Surrounding these cultural features, forest makes up about 80% of the park. The most troublesome invasives are purple loosestrife (*Lythrum salicaria*), Norway maple (*Acer platanoides*), Japanese barberry (*Berberis thunbergii*), black swallow-wort (*Vincetoxicum nigrum*), yellow iris (*Iris pseudocorus*), and Morrow honeysuckle (*Lonicera morrowii*). Various methods of control are being employed, from cutting down Norway maples and pulling up seedlings to releasing beetles (*Galerucella* sp.) to attack the purple loosestrife. The formal garden itself is a source of exotics; Japanese tree lilac (*Syringia reticulata*) growing in the garden across the road from woodland has produced offspring in the forest.

Inventory and mapping of 17 invasive species were completed in 2003, and information on the location, size, density, and distribution of the populations was stored in GIS format. With these data the control phase of the plan was launched.

To pay for the labor to implement the plan, the park tapped various funding sources. The NPS Public Land Corps supported three interns, hired through the Student Conservation Association, who each spent nine months at the park doing the inventory and mapping, assisting with the preparation of the plan and associated compliance documentation, and undertaking control operations in the field. Local Boy Scouts and other volunteers occasionally lent a hand, too. Removing the invasives will eventually include collaborating with nearby Marsh-Billings-Rockefeller National Historical Park (Vermont) to obtain seasonal field personnel. The park also plans to work closely with the Northeast Region's newly established Exotic Plant Management Team, stationed at Delaware Water Gap National Recreation Area (Pennsylvania and New Jersey).

The small size of the park provides a special opportunity to control invasive plants and restore native species. The remaining exotics, says Natural Resource Manager Steve Walasewicz, will then mimic their presence in their native environments, where they are not invasive. ■

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Implementing the Natural Sounds Program

By Bob Rossman

NATIONAL PARKS may seem to be the perfect place for quiet, solitude, and contemplation, yet managers must also address the needs of recreationists who may want to pursue activities that are loud or intrusive. Noise has the potential to affect wildlife and cultural resources and diminishes wilderness values to the extent that desired visitor experiences and expectations may not be realized. The Natural Sounds Program, initiated in 2000, assists a number of parks in dealing with such issues by collecting acoustic data, providing impact assessments, defining problem areas, and recommending potential solutions.

"Park managers must determine the level to which natural sounds are to be protected, preserved, or restored, as well as the type and amount of human-caused sound that is necessary or desirable in light of park purposes."

In 2003 the Natural Sounds Program developed practical guidance for parks in developing soundscape management and noise prevention plans. Guidelines help park field personnel and managers understand and apply the fundamentals of acoustic science. In a related development, the Natural Sounds Program completed a section of the "Interim Final Guidance on Assessing Impacts and Impairment to Natural Resources" (April 2003) to provide assistance in noise impact analysis.

Zion, Hawaii Volcanoes, Haleakala, and Lassen Volcanoes National Parks are using the guidelines to draft proposals for soundscape management plans. These and other parks initiated planning efforts in response to increased sources of noise that could affect park soundscapes. A soundscape management plan suggests the characteristics and appropriateness of existing noise in relation to the natural condition and purposes for which a park was established, providing the basis for scientific assessment of noise impacts associated with proposed actions by the National Park Service or others.

The study of acoustics, as it relates to preserving natural or culturally important sounds in parks, is an evolving science. Acoustic sampling programs are intended to characterize a national park soundscape that may be viewed as "natural ambient" or "baseline," without the sounds caused by the presence and movement of people. Further data collection efforts are made to measure human-related sounds that are imposed on the natural soundscape. The collection of data can involve methods as simple as listening to sounds over a period of time (audibility) and recording their source and duration. Information about weather, particularly wind, must be collected at the same time in order to interpret measurement results. The collection of acoustic data is a prelude to making determinations about sound or noise in national park units. Park managers must determine the level to which natural

sounds are to be protected, preserved, or restored, as well as the type and amount of human-caused sound that is necessary or desirable in light of park purposes.

Another major emphasis for the Natural Sounds Program in 2003 was the initiation of air tour management planning. Under the National Parks Air Tour Management Act, the Federal Aviation Administration (FAA) is the lead agency for producing an air tour plan for each affected park. The National Park Service is a cooperating agency with joint signature authority for the plans. In early 2003, all existing and prospective air tour operators were required to apply in order to engage in this activity. Applications were received for more than 100 park units instead of the expected 55, requiring the preparation of plans for more than 100 parks over the next several years.

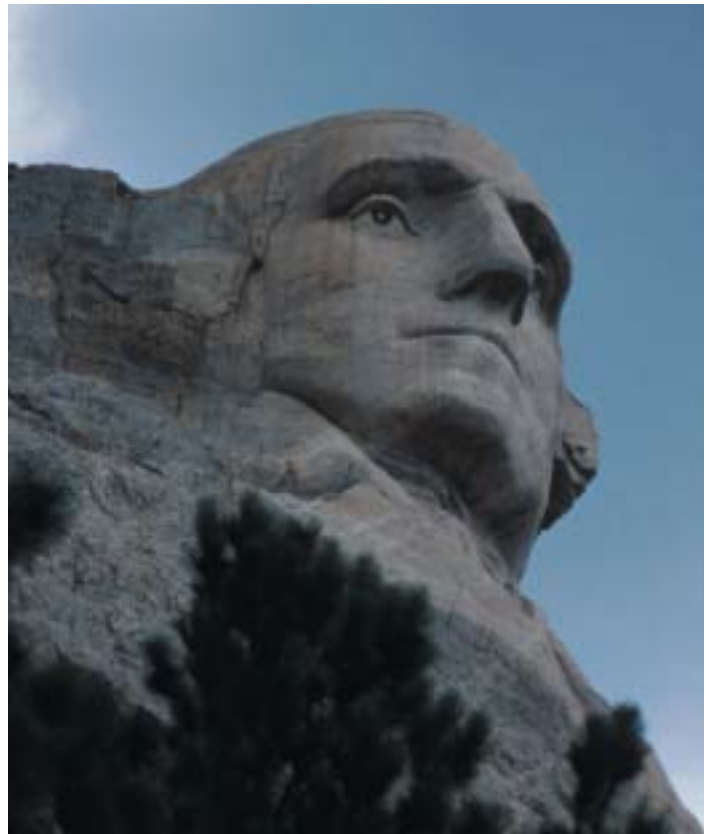


Commercial flight services operating in national parks can produce sound intrusions that diminish the park experience and affect natural resources. However, with careful planning and cooperation these intrusions can be minimized. For example, Badlands National Park boasts a good relationship with its air tour operator, who has agreed to avoid bighorn sheep habitat and to operate the helicopter in a way that minimizes rotor noise. The air tour plan for Badlands accommodates not only the operator's business interests but also the interests of park resource protection, maintaining a quality visitor experience, and safety.

Natural Sounds Program staff, working with FAA counterparts, is developing appropriate planning procedures by which to conduct these efforts. Air tour planning projects were initiated at 15 park units during 2003: Grand Teton, Glacier, Yellowstone, Petrified Forest, Badlands, Hawaii Volcanoes, and Haleakala National Parks; Kalaupapa, Kaloko-Honokohau, and Pu'uhonua o Honaunau National Historical Parks; Puukoloa Heiau National Historic Site; Lake Mead National Recreation Area; Navajo and Canyon de Chelly National Monuments; and Mount Rushmore National Memorial. ■

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Air tour planning was initiated at Mount Rushmore National Memorial (above) and Badlands National Park (left), South Dakota, and several other units of the National Park System in 2003.

NPSFACT

The National Park Service formulates annual budget requests based, in part, on anticipated work levels needed to address a wide variety of potential resource impairment issues in parks. For example, **for FY 2004 it estimates that it will review 40 applications** for proposed new air emission sources within 200 miles of national parks, **inspect 25 new (of approximately 700 active)** mineral extraction operations in parks, and respond to chronic wasting disease in wildlife populations at two national parks. It also estimates that it will treat 83,000 acres (33,615 ha) of invasive exotic plants,* resolve water quantity issues in 10 park units, and assess airborne contaminants in nine parks.

**The National Park Service exceeded its FY 2003 performance goal of containing exotic vegetation on 122,600 acres (49,653 ha) by 144,880 acres (58,676 ha), bringing the total contained to 267,480 acres (108,329 ha). This gain of more than 100,000 acres (40,500 ha) reflects the deployment of seven additional Exotic Plant Management Teams and the continuing priority of parks to address harmful invasive species.*

Park resources protected from Washington Aqueduct discharges

By Jeff Bernstein, Doug Curtis, Sharon Kliwinski, and Gary Rosenlieb

THE U.S. ARMY CORPS OF ENGINEERS (the Corps) began construction of the Washington Aqueduct at the direction of Congress in 1853. Today the Corps owns and operates the Washington Aqueduct as wholesale water production facilities that provide all the potable water to about one million consumers in Washington, D.C., and parts of northern Virginia.

The aqueduct functioned for decades prior to the establishment of the Chesapeake and Ohio Canal National Historical Park in 1971, and now periodically flushes sediment through the park and into the Potomac River. The sediment discharges, their regulation, and their impact on park resources and the ecology of the river have raised public concern and controversy over the past couple of years.

“The aqueduct is one of a few water treatment facilities in the country that still discharges sediment back into a river instead of transporting it to a disposal facility.”

The aqueduct system draws water from the Potomac River above Great Falls, Maryland, and carries it via an underground conduit to water treatment facilities in Maryland and the District of Columbia. During the treatment process, sediments from the river water bind with alum and settle in basins. Several times per year the basins are flushed to remove sediment buildup. Approximately 10,000 tons (9,070 tonnes) of alum-laden sediments are discharged annually to the Potomac River. Two conduits discharge sediments on parklands that flow to the Potomac River; a third discharges directly into the river. Chlorine used in cleaning the sediment basins and potentially toxic concentrations of naturally occurring metals such as iron may also be discharged. The aqueduct is one of a few water treatment facilities in the country that still discharges sediment back into a river instead of transporting it to a disposal facility.

Several agencies are involved in managing resources affected by the discharges. The National Park Service manages the park resources and, because of the unique relationship between the federal government and the District of Columbia, it also manages the Potomac River bed in the district as miscellaneous property for the Secretary of the Interior. The U.S. Fish and Wildlife Service manages resident and migratory fish species in the area of the discharges. The National Marine Fisheries Service is responsible for the shortnose sturgeon, an endangered species under the Endangered Species Act.

In 2001 the sediment discharges spawned numerous congressional inquiries and hearings and the filing of two lawsuits in federal court. The lawsuits claimed that responsible federal agencies did not properly account for the cumulative effects of the discharges on the environment and that the discharges violate the Corps's Clean Water Act permit issued by the U.S. Environmental Protection Agency (EPA).

In light of heightened public scrutiny, the Department of the Interior (the Department), with extensive technical and policy support of the National Park Service and Fish and Wildlife Service, evaluated its legal options and subsequently engaged in renewal of the Corps's discharge permit. Comments submitted during the permitting process focused on the adequacy of technical and scientific investigations underlying the draft permit and that the permit might not adequately protect park and Potomac River resources. The Department called for elimination of the sediment discharges, an option the Corps had resisted.

After two public comment periods, the final permit issued by the EPA included provisions that will result in significant reductions in discharged sediments and other pollutants to protect park and aquatic resources. Barring financial or other potential difficulties, it will take about seven years to build the physical facilities necessary to implement the permit. Because of this delay, the permit also requires that a number of studies requested by the National Park Service, the Fish and Wildlife Service, and the National Marine Fisheries Service be undertaken by the Corps to assess impacts of ongoing discharges on affected resources. This information could prove helpful in devising interim strategies for mitigating resource damage.

Although the Department of the Interior and the National Marine Fisheries Service were largely pleased with the final permit, the Corps was not. It filed an appeal with the EPA Environmental Appeals Board challenging the agency's authority to require environmental studies in the permit. Through facilitated negotiations, the agencies have reached a conceptual agreement that, if adopted after public notice and comment, will ensure that the necessary studies are conducted while meeting the needs of all agencies. Additionally, the agencies are working on a letter of understanding designed to ensure better inter-agency coordination on permit implementation issues.

The interpretation and use of good science and a detailed evaluation of legal options played important roles in shaping the Clean Water Act permit for the aqueduct. In light of the provisions of the final permit and the compliance agreement, the National Park Service and other federal parties are optimistic that operation of the Washington Aqueduct will eventually cease harming park resources and the aquatic resources of the Potomac River. ■

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Several times per year sediments and potentially toxic concentrations of iron and other naturally occurring metals are flushed from a water treatment facility and flow through this discharge structure in Chesapeake and Ohio Canal National Historical Park en route to the Potomac River. The discharge permit, held by the U.S. Army Corps of Engineers, was reviewed in 2003, resulting in significant future reductions in the amount of sediments and other pollutants that can be released from the facility to protect park and river resources.

Restoration

“Restoration uses the past not as a goal but as a reference point for the future. If we seek to re-create [ecological]... communities of centuries past, it is not to turn back the evolutionary clock but to set it ticking again.”

—Donald A. Falk
*Discovering the Future,
Creating the Past: Some Reflections
on Restoration*

Congress declared the National Park System to be the “cumulative expressions of a single national heritage” because it includes the “superlative natural, historic, and recreation areas in every major region of the United States.” Sustaining the diverse and awe-inspiring natural and cultural wonders of this nation for future generations increasingly involves healing the wounds of the past. For this reason, ecological restoration—intensive efforts to recover disturbed natural systems—plays an important and growing role in NPS efforts to fulfill its mission. In 2003, restoration efforts took many forms, from reestablishing natural conditions along a cave tour route and halting unnatural erosion to controlling exotic rats on Anacapa Island and returning the swift fox to the Badlands of South Dakota. In many cases success was enhanced by working with dedicated partners, including corporations, state agencies, and private citizens. Restoration involves a long-term commitment of energy and resources, but as the articles in this chapter make clear, the benefits are priceless.



Since 2000, resource managers of the National Park Service and scientists from the Natural Resource Conservation Service have been working together to restore the Oak Island sandscape at Apostle Islands National Lakeshore, Michigan. They established plots for monitoring in areas where they had heavily planted and where they had tried various techniques to control exotic vegetation.

Restoration of Oak Island sandscape at Apostle Islands National Lakeshore

By Julie Van Stappen

TWENTY-ONE ISLANDS and a strip of mainland set in a matrix of Lake Superior comprise Apostle Islands National Lakeshore in northwestern Wisconsin. The lakeshore is well-known for its diverse, sandy coastal features, known as sandscapes. They include sandspits, cusped forelands (sandspits that are wider than they are long), tombolos (sandbars that connect two islands or an island and the mainland), a barrier spit, and numerous beaches, which are among the highest quality of any in the Great Lakes region. Sandscapes are very popular visitor-use areas and are among the few places available for boats to access the islands. However, vegetation on sandscapes is very sensitive to trampling.

Park resource managers have been monitoring the lakeshore's 17 significant sandscapes since 1988. Among those monitored is a 1.6-acre (0.7-ha) cusped foreland on Oak Island that has a long history of human use. Monitoring results over a 10-year period showed that Oak Island housed the most threatened sandscape and required restoration.

"Vegetation on sandscapes is very sensitive to trampling."

Since 2000, park natural resource staff has been working with the Natural Resource Conservation Service's (NRCS) Plant Materials Center in Rose Lake, Michigan, to restore Oak Island's sandscape. Scientists from the NRCS center gathered native plant materials from the site and began propagating 15 species. In 2001 they set up 18 plots for determining appropriate lighting conditions to establish propagated plants, and also collected additional plant materials for restoration. Park maintenance staff assisted with restoration by installing floating boardwalks, which have been very effective in directing visitors and minimizing their impacts on sandscapes.

In late May 2002 the majority of the on-site restoration occurred: a Northland College field ecology class planted 3,200 propagated plants, with NRCS and park staffs providing technical assistance. Follow-up monitoring included establishing 20 plots in 10 of the more heavily planted areas. In addition, park staff set up plots for determining the effectiveness of pulling vs. treating orange hawkweed (*Hieracium aurantiacum*), the most abundant exotic species on the sandscape.

Results of the experimental plots from 2001 showed that plants did equally well in sunny and partially shady conditions. Plants under shady conditions did the best. Plants such as horsetail-like equisetum (*Equisetum arvense*) did extremely well the first year, tapering off during the second year. Plant counts of blueberry (*Vaccinium angustifolium*), rose (*Rosa blanda*), and Pennsylvania sedge (*Carex pensylvanica*) steadily increased with time; common juniper (*Juniperus communis* L.) had a fairly low survival rate (44%) after the first year, but once established did very well.



This cusped foreland on Oak Island in Apostle Islands National Lakeshore is one of many coastal features comprising the park's 17 significant sandscapes. These lakefront areas are popular with visitors, but are also fragile, easily trampled ecosystems.

Park managers were very encouraged by the results from the 2002 plots: from July 2002 to September 2003, nonnative species decreased from 66% to 41% of the plant count, clearly indicating native species outcompeting nonnative ones. Changes in areal coverage revealed decreases in bare ground and nonnative species and increases in vegetative litter and native species. Results at the plots of orange hawkweed showed that pulling was more effective than chemical treatment.

This restoration effort was challenging. Visitor trampling had removed the thin layer of organic matter that normally provides some protection from extreme conditions, resulting in pure sand, a very harsh environment for new plants. Watering after planting was not feasible because of the difficulty in getting to the site. The only way to get personnel, plants, and supplies to the restoration area was by boat across Lake Superior, and planting needed to be done in spring when storms are frequent. In addition, high visitor use and impacts from deer browsing resulted in less improvement of certain areas after planting.

Lessons learned from the 2003 monitoring results will be applied during restoration efforts in 2004. First, plants propagated from local plant material established successfully and were effective in increasing native plant populations. Second, having a fairly large number of people do the initial plantings was extremely helpful, minimizing the length of time between receiving plants and getting them into the ground. Third, peat pots caused problems by popping up with changing moisture conditions, and the perlite, which is mixed with soil, may have attracted deer. ■

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Positive ecosystem changes on Anacapa Island from rat eradication

By Kate Faulkner, Gregg Howald, and Steve Ortega

THE MOST IMPORTANT step for the restoration of the Anacapa Island ecosystem at Channel Islands National Park, California, was removing black rats (*Rattus rattus*). The exotic rats threatened and preyed upon native species. Beginning in 2001 and continuing the next year, the National Park Service and its partner in the restoration project, Island Conservation and Ecology Group, applied rodenticide to Anacapa Island, as described in *Natural Resource Year in Review—2001* and *2002*. The natural recovery and restoration of the Anacapa ecosystem since eradication have been dramatic, with many rapid, positive changes in native wildlife populations.



A video camera documents a black rat preying on an artificial “bird nest” on Anacapa Island (above, left). Investigators deployed artificial nests, consisting of a brown chicken egg and a plasticine egg, around the island to monitor the presence of rats and to track rates of nest depredation. To mimic Xantus’s murrelet nests, investigators placed eggs in rocky crevices, under boulders, and beneath shrubs. They determined the cause of predation by comparing chew marks of known nest predators with marks left on plasticine eggs. Xantus’s murrelet eggs that have been found on Anacapa in recent years are few in number and have had large bite marks (top) in the shells that are consistent with rats.

■ Seabirds

Within four months of the fall 2002 rodenticide baiting treatment, biologists detected the highest numbers of cavity-nesting seabirds ever recorded successfully breeding on the island. For the first time in decades, rare Xantus’s murrelets (*Synthliboramphus hypoleucus*) nested in areas from which rats had previously excluded them. Nesting activity of Xantus’s murrelets in 2003, measured using boat-mounted radar, increased by 58% to 200% compared with the prior three years. In addition, two downy Cassin’s auklet chicks, a new species for the island, were unexpectedly discovered in what was previously prime rat habitat.

■ Anacapa deer mice

Populations of the endemic Anacapa deer mouse (*Peromyscus maniculatus anacapae*) have increased dramatically on east Anacapa, the first of the Anacapa islets from which rats were eradicated in November 2001. Considering that rats had extirpated the native deer mice from east Anacapa, to have the mice present in such high numbers is a spectacular change to that ecosystem. Project staff released wild captive deer mice onto middle and west Anacapa in April 2003 (the spring following the eradication treatment). The mice are reproducing, and population increases are surpassing those measured on east Anacapa the prior year.

■ Birds of prey

Birds of prey were at risk of secondary exposure to the rodenticide from preying on or scavenging poisoned rats and nontarget Anacapa deer mice. To avoid exposure, biologists live-captured or translocated as many birds of prey as possible. Currently the diversity and numbers of birds of prey on Anacapa are similar to those before the rat eradication.

The final determination that all rats have been eradicated from Anacapa will not be made until fall 2004 following two years of post-project monitoring. However, the dramatic changes in the ecosystem, coupled with no sign of rats, are early indications of a successful conservation project. Monitoring will continue for a number of years to more fully understand the response of the ecosystem following removal of nonnative rats. ■

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Shoreline restoration at Assateague Island National Seashore

By Betsie Blumberg

RESTORATION OF NORTHERN Assateague Island (Maryland), undertaken to mitigate the effects of a jetty system built in the 1930s to stabilize the adjacent Ocean City Inlet, is proceeding on schedule. The two-phase project, conducted by the U.S. Army Corps of Engineers in partnership with the National Park Service, addresses the long-term effects of the stabilized inlet on the sand supply for Assateague Island. The jetties have prevented the natural movement of sand along the shore from north to south, resulting in unnatural erosion and accelerated island migration. Since the 1930s, portions of northern Assateague have shifted westward more than 325 yards (297 m).

“The objective ... is to restore the island’s sand budget and ensure that coastal processes continue to dictate the evolution of the island.”

The objective of this project is not traditional beach nourishment to protect the shoreline from storm damage or to halt erosion; rather, it is to restore the island’s sand budget and ensure that coastal processes continue to dictate the evolution of the island. The transport of sand across the island during storms is a key dynamic

Jetties have prevented the natural north-to-south movement of sand along Assateague Island National Seashore, resulting in unnatural erosion and accelerated island migration. The first phase of a project to restore the island’s sand budget and ensure that coastal processes will dictate the island’s evolution was completed in 2003. Sand was dredged from a shoal 4 miles (6.4 km) offshore and brought to the Atlantic side of the national seashore by boat where it was pumped as a slurry through a pipeline onto the beach. Bulldozers moved it into place according to the project design. The island has been widened 125 feet (38 m) over a distance of 5 miles (8 km).

influencing both the physical and biological attributes of Assateague Island.

Phase I of the project was the replacement of 1.5 million cubic yards (1.1 million cubic meters) of sand on northern Assateague Island. That operation was completed in 2003. Phase II began at the end of 2003 and will go on for at least the next 25 years: on an annual basis, 150,000 cubic yards (115,000 cubic meters) of sand will be mined in and around the inlet, where it is currently being trapped, and deposited in the surf zone 2 to 3 miles (3.2 to 4.8 km) south of the inlet. This sand will naturally wash up onto Assateague and nourish the island.

The project preserves not only the natural action of the shoreline but also the associated habitat harboring several threatened and endangered species, such as the piping plover (*Charadrius melodus*), sea beach amaranth (*Amaranthus pumilus*), and state-listed endangered tiger beetle (*Cincindella dorsalis media*). A companion long-term monitoring program will evaluate the progress of the project, which may be modified when conditions warrant. ■

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Collaboration key to swift fox recovery

By Brian Kenner

ON SEPTEMBER 13, 2003, one more missing piece of the Great Plains ecosystem was returned to Badlands National Park. Wild-born swift fox (*Vulpes velox*), translocated from Colorado, were released into the park. This curious and unwary housecat-sized fox, once common throughout the short- and mixed-grass portions of the Great Plains from Canada to Mexico, had fallen victim to trapping and poisoning targeted at wolves and coyotes.



A radio-collared swift fox pokes its head out of its artificial den in Badlands National Park, South Dakota. After being captured in Colorado and transported to Badlands, the animals were held two weeks in quarantine and then translocated to a suitable release site in the park.

The swift fox is a state-listed threatened species in South Dakota, and its restoration to the Badlands is a result of collaboration among a variety of interests. The Swift Fox Conservation Team (SFCT), an ad hoc group of private, state, federal, and Canadian biologists, was established to further management and restoration of the species. Contacts made with team members at annual meetings proved essential to Badlands' efforts to restore the fox. Also essential to this project is the park's cadre of biologists and technicians funded by the Natural Resource Challenge to restore the black-footed ferret, who have considerable experience in endangered species restoration.

One SFCT member, the Turner Endangered Species Fund (TESF), began a project to return the swift fox to Ted Turner's Bad River Ranches in South Dakota by translocating 30 wild swift fox in 2002 from healthy populations in Wyoming to the ranches. Using the TESF's experience and expertise, Badlands biologists cooperated with scientists from the USGS Northern Prairie Wildlife Research Center and South Dakota State University (part of the Great Plains Cooperative Ecosystem Studies Unit), and obtained funding from the Natural Resource Preservation Program of the USGS Biological Resources Division and the Cooperative Conservation Initiative of the Department of the Interior for a three-year program to capture and release 30 fox per year.

In August 2003, Badlands biologists traveled to Colorado and, with assistance and support from the Colorado Division of Wildlife (another SFCT member), captured 30 swift fox. After a two-week quarantine the animals were released into the park. By December 2003 nine mortalities had occurred. Most of the fox had established themselves in the park and on the surrounding Buffalo Gap National Grassland (the USDA Forest Service is another SFCT member). Large prairie dog complexes and other plentiful rodents and lagomorphs (rabbits and hares) provide the prey base needed for the fox to get established in the area.

Every released fox is radio-collared and will be monitored throughout the year. As the population becomes established and reproduction occurs, park staff will capture and collar the pups to track the population through successive generations. ■

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Interagency implementation of the Comprehensive Everglades Restoration Plan

By Elizabeth Crisfield

In 2000, Congress passed the Comprehensive Everglades Restoration Plan, a \$7.8 billion state and federal partnership. The U.S. Army Corps of Engineers and South Florida Water Management District initiated project planning and established interagency working relationships to support implementation of the plan. The South Florida Natural Resources Center coordinates National Park Service involvement in this interagency effort, and a number of additional scientists have been hired in response to the center's new restoration responsibilities.

The plan comprises 68 project components that yield benefits for the natural ecosystem while providing for urban and agri-

cultural uses. The components were described conceptually in the plan authorized by Congress, but each will undergo detailed assessments to select a refined combination of structural features and operations. In 2003, detailed planning started for several components near Everglades and Biscayne National Parks where teams of NPS scientists help evaluate alternatives and select environmentally preferred plans.

Final negotiations on the programmatic regulations, which provide detailed guidance on implementation, also took place in 2003. These regulations, authored by the Corps of Engineers, require Department of Interior and State of Florida concurrence. Environmental

organizations pushed for a stronger role for the Department of the Interior in the interagency scientific coordinating body described in the regulations. They also lobbied to have interim ecosystem restoration goals included. National Park Service scientists and managers assisted policy makers in evaluating these controversial issues and will continue to work toward accomplishing restoration goals consistent with the mission of protecting national park resources. ■

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Wind Cave restoration guided by balancing cultural and natural resource preservation

By Rodney D. Horrocks and Marc J. Ohms

IN THE 1890S, when early developers of Wind Cave, South Dakota, blasted narrow passages to create public tour routes, they were making history. They were also altering the cave's fragile natural conditions. Many resource managers in the National Park Service are acrobats in the balancing act of cultural vs. natural resources, but this is the first time this act has been performed with the help of a cultural landscape survey in an NPS-administered cave. A project to restore the Natural Entrance Tour Route in Wind Cave was funded in FY 2003 through the Natural Resource Preservation Program and led to the detailed survey.

In November 2002, a team of historical building and landscape architects pioneered new ground as they evaluated cultural cave resources along the Natural Entrance Tour Route. Until that time the National Park Service had never completed a cultural landscape survey in a cave, so no previous work in a similar setting could guide the team. As they explored "new territory," the team identified cultural resources such as trails, handrails, stairs, retaining walls, artifacts (e.g., 25¢ cave tickets, flash-powder bottles, Lucky Strike cigarette packs, and wine bottles), signatures etched on cave walls, blast holes, and trail-construction debris. Although much of the debris would be removed to restore the cave's natural conditions, the cultural landscape survey team made preliminary recommendations that called for intentionally placed rocks lining the trail, or for leaving particular deposits that were not blocking cave passages in place.

In addition to early developers, the Civilian Conservation Corps further modified tour routes in the 1930s and park staff paved trails with asphalt in 1956. These projects amassed a tremendous amount of debris, including blast rock, gravel, sand, displaced sediment, asphalt, concrete, and wood. Workers dumped most of this construction debris in side passages, altering the natural environment. They also used it to level walkways. More subtle human impacts include dust, lint, hair, and skin flakes shed from 90,000 annual visitors, and dust from development, which has built up on all cave surfaces. This material dissolves and hides the true colors of cave formations and provides unnatural food sources for cave biota.

In preparation for this project, staff mapped and digitized the locations of artificial-fill deposits along three developed tour routes within the cave. They photographed each deposit for later comparison with the restored sites. Preparation work also involved compliance with the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act, including consultation with 19 Native American tribes with cultural affiliations with the park. In addition, a representative of the State Historic Preservation Office visited the cave to discuss how to manage any cultural artifacts found during the project.

The team of seven seasonal laborers did not restore as much of the trail as originally planned. Seasonal staff found artificial-fill deposits to be much deeper than expected; many of these deposits were more than 5 feet (1.5 m) deep and contained tons of debris, which had to be



An arduous restoration project at Wind Cave transformed Lena's Cave (pictured) and other features along three developed tour routes from a debris-covered depression (top) to a natural-functioning and -looking cave passageway (bottom). Park staff removed 36 tons of blast rock, gravel, sand, and other materials that were deposited when the access trails were constructed, revealing rich cave detail and color.

manually hauled out of the cave. Nevertheless, by the end of the six-month project, staff had restored 750 feet (229 m) of the tour route and removed 36 tons of debris from the cave, resulting in a dramatic improvement of the natural cave environment.

This project was the first phase of a multiyear project to mitigate impacts of development and more than 100 years of touring. The cultural landscape survey was integral to protecting and preserving both natural and cultural resources in the cave. Using what was learned during this initial phase, park staff is confident that future projects will complete the restoration of the remaining paved tour routes in Wind Cave. ■

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Hurricane Isabel: A case study in restoration response at three Mid-Atlantic national seashores

By Rebecca Beavers and Julia Brunner

HURRICANE ISABEL made landfall at Cape Lookout National Seashore along the North Carolina coast on September 18, 2003. The powerful northeast quadrant of the storm also struck Cape Hatteras National Seashore, opening a 1,700-foot-wide breach in the narrow barrier island park. Additionally, storm waves washed over the lower portions of Assateague Island National Seashore in Maryland and Virginia, piling sand on parking lots and roads. Although these three barrier island parks were affected by the storm, Cape Hatteras faced the greatest restoration effort. The only road to give island residents access to their homes within this national seashore was damaged and required immediate attention. The need to restore public access influenced the park's decisions related to natural resource management.

Hurricanes and other storms are vital for maintaining the barrier islands along the Atlantic Coast. Storm waves wash over the islands, depositing sand that stretches across the islands in fanlike shapes and adds elevation. As the beach on the ocean side erodes, the corresponding buildup of sand toward the more protected sound side preserves the island by allowing it to remain above rising sea level. If this process did not occur, barrier islands would break apart very quickly and be inundated.

At Cape Lookout and Assateague Island National Seashores the National Park Service is able to maintain natural barrier island processes because infrastructure such as roads and homes is minimal. The fans of sand resulting from Hurricane Isabel are being preserved for detailed geologic study and are playing out their natural role of island preservation. Indeed, at Assateague, a prestorm shoreline

restoration project to mitigate the impacts of jetties constructed at Ocean City (see page 75) was designed to allow the natural storm process to continue. Nevertheless, the National Park Service facilitates visitor use at these national seashores. Cape Lookout is repairing the docks to restore boat access to the barrier island. Additionally, the interdunal sand road—a transitory, unpaved driving route—has been relocated and meanders across the new sand deposits. On the south end of Assateague Island, portable visitor-use facilities that were

“The presence of six villages within the park results in private and state ‘restoration’ actions that alter many of the park’s natural resources, including barrier island dynamics.”

demobilized in preparation for the storm are being reinstalled on the new sand deposits. At these national seashores, requests for NPS protection of private and state infrastructure are minimal.

The situation at Cape Hatteras, however, is quite different. The State of North Carolina has the right to maintain State Highway 12 running through the park. Moreover, the presence of six villages within the park results in private and state “restoration” actions that alter many of the park’s natural resources, including barrier island dynamics. The breach or inlet opened by Hurricane Isabel severed Highway 12 northeast of Hatteras Village, cutting off residents from



A 1,700-foot passage between the Atlantic Ocean and Pamlico Sound at Cape Hatteras National Seashore, North Carolina, was created on September 18, 2003, when 25-foot waves and a storm surge caused by Hurricane Isabel slammed into the Outer Banks. The breach was subsequently filled and the road reconstructed within two months of the storm.



South of Cape Hatteras, Cape Lookout National Seashore has no permanent road. Sediments that washed over the park have been preserved as geologic features for visitors to explore and contemplate.

their prestorm mode of travel along asphalt roads. The situation was considered an emergency because no other means of access, such as bridge, causeway, or ferry, is available to the village. Accordingly, the U.S. Department of Homeland Security directed the Army Corps of Engineers to fill the new inlet. Once the inlet was filled, the state transportation department reconstructed the broken segment of highway.

Private property owners in the park also tried to restore prestorm conditions by reconstructing berms between their homes and the park beach, using the 2–4 feet (0.6–1.2 m) of sand that had washed onto their property. Unlike the case at many barrier islands, large berms are not natural to Cape Hatteras. In an effort to maintain barrier island dynamics on parklands, the park did not allow residents to use park beaches as a sand source for the berms, and required the berms to be built as far onto private property as possible.

The sheer magnitude of Hurricane Isabel's effects on the infrastructure along the barrier islands has heightened the awareness of state agencies and local communities of the need for environmentally sound, long-term transportation planning. Cape Hatteras National Seashore has long been involved with the Outer Banks Task Force, an interagency panel that has studied Highway 12 problems for 10 years. Spurred by the storm, the panel is finalizing its recommendations to guide the interagency response to any future inlets created by storms on the Outer Banks. If the results of these collaborative planning efforts can be implemented after future storms, community restoration actions may become more consistent with natural coastal processes. ■

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NPSFACT

In 2000 the National Park Service set a five-year goal under the Government Performance and Results Act (GPRA goal 1a1A) to restore **10.1% of 222,300 acres (90,032 ha), or 22,500 acres (9,113 ha)** of parklands disturbed by development or agriculture.* The Park Service is on course to meet the FY 2005 target date, with cumulative totals of **4,716 acres (1,190 ha)** restored as of FY 2001, **8,656 acres (3,469 ha)** as of FY 2002, and 13,525 acres (5,478 ha) or 60% of the goal as of FY 2003.

**The goal is specific to disturbed lands restoration (i.e., disturbed by development or agriculture) and does not address restoration of fauna, control of invasive plants, and use of fire as a restoration tool. Causes of disturbance include facilities, roads, mines, dams, abandoned campgrounds, farming, grazing, timber harvest, and abandoned irrigation ditches. The goal is updated every three years to account for progress and changes in the total area being targeted for restoration.*

Interagency collaboration helps pinpoint Hurricane Isabel impacts

By Rebecca Beavers and Tim Smith

Several agencies collaborated in the aftermath of Hurricane Isabel to assess the storm's impacts on Cape Hatteras and Cape Lookout National Seashores on the North Carolina Outer Banks. Once the storm had made landfall in North Carolina, the National Oceanic and Atmospheric Administration (NOAA) flew the coast and deployed a new research digital aerial-photography system. The tool recorded coordinates associated with 1.2-foot-resolution digital images and aircraft positional and attitude data. In response to the need for rapid assessment of hurricane impacts, the USGS Rocky Mountain Mapping Center is developing a method to process poststorm imagery and make it available to land managers. Their technique uses the aircraft positional and attitude data to ortho-rectify or correct the aerial imagery through a batch process, saving many hours of processing time. The imagery will be made available to the public over the Internet. Users will be able to call up the images in mosaics corresponding to regions of interest.

The USGS Center for Coastal and Watershed Studies and NASA also collected pre- and poststorm EAARL (Experimental Advanced Airborne Research Lidar) data to analyze the impacts of the hurricane. The high level of detail in these topographic and ocean-floor data provides a way to quantify amounts of sediment moved by the storm and understand the geologic impacts in the national seashores. Maps produced for a new inlet area at Cape Hatteras in the days following the storm helped natural resource managers visualize the new shape of the park. ■

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Conserving Threatened and Endangered Species

“The strength of each country’s conservation ethic is measured by the wisdom and effectiveness of its legislation in protecting biodiversity. Without dispute the most important conservation law in the history of the United States is the Endangered Species Act.”

—E. O. Wilson,
The Future of Life

A great many of the national parks were set aside for conservation because of their spectacular natural beauty. The National Park Service took them in as a whole, and now we are beginning to understand how the parts function and interact. Passed 30 years ago, the Endangered Species Act contributes to park preservation goals by helping to ensure that the biotic parts of these ecosystems are not lost. The job begins with knowing what is in the parks and regularly assessing how the populations of federally listed species are faring. That information is compiled in the NPS Endangered Species Act database, which is now on a website available to NPS staff. With this information, we can determine which species are recovering and focus our efforts on those that continue to decline or restore those that have been lost from the parks. A growing number of species are being restored successfully, and a few of their stories follow in this chapter. For the future we will continue to increase our knowledge of these rare populations of plants and animals and take action when needed to secure their persistence in the national parks.



Formerly widespread on the island of Hawaii, Mauna Loa silversword, a federally listed endangered plant species, declined primarily as a result of disturbance by feral pigs, goats, and mouflon sheep. Hawaii Volcanoes National Park has been fenced to keep out these nonnative species and as of November 2003 had planted 6,800 seedlings over three years, with 83% survival. The core of the restored plants are within two 30-acre (12-ha) exclosures, which provide additional protection from feral animals.

Progress on threatened and endangered species in national parks

By Peter A. Dratch



For the protection of the federally endangered Eureka Dunes evening-primrose, in 2003, staff at Death Valley National Park closed a portion of a park road, relocated a campground, and scarified compacted soils to promote natural reseeding of the plants. A combination of grants and funds from the Recreation Fee Demonstration Program paid for the project.

Table 1. Number of federally listed species in the National Park System listed by status and the number of current or historical populations in national parks		
Status Trend in National Parks	Number of Species	Number of Populations
Endangered	200	597
Threatened	84	419
Experimental	3	13
Proposed	4	9
Candidate	51	84
Total	342	1,122

Table 2. Number of endangered, threatened, proposed, and candidate species and populations in the National Park System by taxon		
Group	Number of Species	Number of Populations*
Plants	148	244
Mammals	39	243
Birds	50	337
Reptiles	18	124
Amphibians	6	9
Fish	35	100
Invertebrates	46	65
*Number of populations reflects both current and historical populations in parks.		

THROUGH TARGETED RESTORATION projects and training at the regional and national levels, national parks have an increasingly important role in species recovery under the Endangered Species Act (ESA). In the past year, 284 endangered or threatened species of plants and animals were recorded on lands managed by the National Park Service, with another 55 species either proposed for or designated as candidates for listing (table 1). An additional 246 populations have historically existed in parks, and in many cases these could be restored.

Plants remain the largest category of listed species in the national parks (table 2) and are increasingly the target of recovery efforts funded by the Natural Resource Preservation Program (NRPP). Mauna Loa silversword (*Argyroxiphium kauense*) was reestablished at Hawaii Volcanoes National Park with NRPP funds designated for threatened and endangered species this year, and three of the top four projects chosen for FY 2005 funding were for plant restorations—the fourth was for the dwarf wedgemussel, a mollusk. The NPS Endangered Species Act database details the status and trends of these

species in each park. It not only suggests potential restoration projects, but also enables park staff to evaluate progress toward their goals for these species.

Although the Pacific West Region has the greatest number of federally listed species and park populations, all regions have listed species that require particular management attention (table 3). Some solutions that benefit these species are implemented by parks on their own. For example, at Death Valley National Park (California and Nevada), a road and a campground occupied habitat of two endangered plants, the Eureka Dunes evening-primrose (*Oenothera californica* ssp. *eurekensis*) and the Eureka Valley dune grass (*Swallenia alexandrae*),

“The NPS Endangered Species Act database details the status and trends of these species in each park.”

“Plants remain the largest category of listed species in the national parks ... and are increasingly the target of recovery efforts.”

Table 3. Number of federally listed, proposed, and candidate species and populations in each region of the National Park System, and the park within each region with the most of those species

Region Populations	Number of Species	Number of Populations
Alaska (Kenai Fjords National Park)	10	14
Intermountain (Capitol Reef National Park)	70	247
Midwest (Indiana Dunes National Lakeshore)	22	99
National Capital (C&O Canal, Prince William Forest Park, and Rock Creek Park)	4	19
Northeast (Gateway National Recreation Area)	24	61
Pacific West (Haleakala National Park)	194	391
Southeast (Everglades National Park)	104	291

Table 4. Population trends of federally listed, proposed, and candidate species in the National Park System for 2002

Status Trend in National Parks	Number of Populations	Percentage of Populations
Not at risk	82	7.2
Stable	225	19.9
Increasing	93	8.2
Declining	101	8.9
Extirpated	204	18.0
Unknown	402	35.5

in addition to six endemic beetles, one endemic bee, and several other special-status plants. After consulting the U.S. Fish and Wildlife Service and addressing provisions of the National Environmental Policy Act, the park closed a portion of the road, relocated the campground, and scarified the ground to promote reseeding of the plants. A combination of grants and funds from the Recreation Fee Demonstration Program paid for the project.

Park personnel took advantage of training offered at the national and regional levels for techniques in managing listed species. “Scientific Principles and Techniques for Endangered Species Management” was offered for the first time at the Horace M. Albright Training Center in February. The course was a joint effort with the U.S. Fish and Wildlife Service, with instructors and students coming from both bureaus. A one-day course, “Modern Genetics for Resource Managers,” was held in conjunction with the George Wright Society meeting in San Diego in the spring. The genetics examples came from studies conducted in national parks and demonstrated how new molecular research methods could answer population questions that are important to management. Section 7 consultation training (Endangered Species Act) was offered several times in the Intermountain Region, and plans are under way to bring this course to other regions.

The National Park Service is directing more of its funding to listed species whose need is most immediate: this year the amount spent on declining and extirpated populations went up, while dollars spent on stable and increasing species went down. (Money is spent on extir-

pated populations in preparation for their restoration.) To continue this trend, management summaries have now been completed for almost all of the threatened and endangered species that occur in the national parks. They relate basic biological information in addition to the recovery goals for the species on a website in a form that is accessible to resource managers.

The NPS ESA database summary clearly points to areas where the National Park Service can improve with respect to threatened and endangered species. The number of populations where parks reported the status as unknown remains at about 35% (table 4). One way parks can reduce this percentage is through coordination with the Inventory and Monitoring Program because listed species are a priority in many Vital Signs monitoring plans. ■

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Condors on the Colorado Plateau reach new heights

By Elaine F. Leslie

ON THE SOUTH RIM of Grand Canyon National Park, Arizona, high in a band of Redwall Limestone, a six-month-old California condor chick dances on the edge of a precipice overlooking the Colorado River. In March 2003, biologists first suspected that condors #123 and #127 were incubating an egg. (California condor studbook identification numbers signify the bird's parentage, genetic integrity, and diversity.) Although biologists and Nestwatch volunteers had continually monitored the parents' activity and behavior since suspecting there was an egg, the chick could not be confirmed until it moved to the entrance of the cave at five months of age. The only way to see the nest site, which rests 800 feet (244 m) above the ground, is to take an arduous 12-mile hike into the canyon. Park biologists observed the chick stretching out its long wings and flapping without lifting off, in preparation for the day in late October or early November when it would step beyond its rocky nursery.

Over the past 10 years, condors have been restored to several locations in California and Arizona, and the California population of condors hatched one wild chick in 2003. But during a nest site cleanup, the bird appeared emaciated and stunted and had to be emergency airlifted from its nest cave and later euthanized. The condor's parents had brought trash—glass, metal conductors, and bottle caps—into the site, apparently simulating the feeding of calcium supplements, which are a requirement of the condor diet. However, a chick cannot pass the foreign objects through its system; respiratory damage occurred, resulting in pneumonia.

The dietary necessity of calcium supplements, which has persisted for thousands of years, was revealed during analyses of nest contents from an earlier failed nest site at Grand Canyon. Investigators discov-

"In March 2003, biologists first suspected that condors #123 and #127 were incubating an egg."

ered calcium bone fragments brought in by adult condors from a much earlier period: Pleistocene remains of horse, bison, and musk ox. These particles were found in the nest in a layer beneath this year's collection, which also included the bottle caps and glass.

Biologists participating in the multiagency cooperative effort closely monitored feather development, crop size, and activity levels of Grand Canyon chick #305. As it neared fledging from its lofty perch, biologists remained cautiously optimistic.

The monumental flight finally occurred at 1:30 p.m. on November 5, 2003. The chick jumped from the cave, looked for a nearby landing perch, and realizing there was none, ungracefully circled and landed about 600 feet (183 m) below the cave.



Biologists and volunteers at Grand Canyon National Park waited anxiously from March until November 2003 when the condor chick fledged, the first time for this occurrence in the canyon in at least 100 years. Condor #305 marks the first successful fledging of a condor in the wild in North America since the 1980s.

Having a condor hatch and fledge in the wild—something that has not happened anywhere since 1984 and not in the Grand Canyon for at least 100 years—is indeed a measure of success. However, wild rearing of the chick and protection from human-caused and environmental contaminants ultimately will determine long-term preservation of this species, which has been brought back from the brink of extinction. ■

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NPSFACT

Of the **1,122 populations of endangered species*** that occurred historically in national parks, **244 (more than 20%) are now gone.** However, because the habitats for many of these species are preserved in the parks, opportunities exist for their restoration. Recent successful restorations include trailing phlox in Big Thicket National Preserve, the wolf in Grand Teton National Park (via Yellowstone), and the Mauna Loa silversword in Hawaii Volcanoes National Park.

**This total includes federally listed threatened and endangered species, in addition to species that are proposed and candidates for listing under the Endangered Species Act.*

California condor returns to Pinnacles National Monument

By Cicely Muldoon and Rebecca Leonard

Aside from geological and scenic interest, [Pinnacles National Monument] is important as one of the last strongholds and breeding places of the California condor.

—Guide to the National Monuments, ca. 1930

AFTER FOUR YEARS of planning, and four years short of the park's centennial, Pinnacles National Monument, in cooperation with the Ventana Wilderness Society and the U.S. Fish and Wildlife Service, has brought the California condor home. One adult and six juvenile condors resided in a newly constructed facility designed to house the birds while they became familiar with Pinnacles' rugged terrain. The young condors were hatched at the San Diego Wild Animal Park, housed at the Big Sur release site in central California for five months, and transferred to Pinnacles in mid-September 2003. The juvenile birds spent three months in the release facility with the adult mentor condor. Two of the juveniles were released on December 20, 2003, with four more following on January 5. By January 26, following the recapture of two condors that had been roosting on the ground and were vulnerable to predation, all six juveniles were flying free in the monument.

Park staff overcame many hurdles to return condors to this part of their historical range, including two environmental assessments, extended public review, and an unexpected relocation of the release

“Park staff has worked hard to build understanding and support for the condor reintroduction program with neighboring landowners and surrounding communities.”

site. Working through the logistics for the new release site, which included bringing water to a roadless area, carrying innumerable loads of construction materials up steep terrain, and working with neighboring landowners to construct an access trail across private property, slowed the project by more than a year. Fortunately, with the strong support of park neighbors and project partners, the return of the California condor to the park is back on track. Following the successful release of the first six California condors at Pinnacles, another cohort of juveniles will be transferred to the facility and held for release in fall 2004. The release program will continue over a projected 3- to 15-year period, depending upon how soon the goal of a wild population of 20–30 condors within the park is achieved.

Staff's hopes that the park will be a viable release site are high. Park features bear promising names for the reintroduction—Condor Gulch, Condor Crag—and Pinnacles' craggy volcanic formations are excellent, historical condor nesting habitat. Condors are believed to have nested within the park until the 1930s, and the last confirmed condor sighting was in 1982. With the ability to fly more than 200 miles (322 km) a day, and with resident wild condors only 45 miles (72 km) away on the Big Sur coast, time will tell if the condors released at Pinnacles will once again take up residence in the rugged formations of the 24,000-acre (9,720-ha) park.

If successful, Pinnacles National Monument will be the most accessible of all the condor release sites and a destination for those hoping for a glimpse of one of the rarest and most notorious birds



A vulture with a 9.5-foot (2.9-m) wingspan, the California condor is the largest flying bird in North America. The juvenile birds warm their wings in the morning sun.

in the United States. The monument is only 100 miles (161 km) south of the greater San Francisco Bay Area, which has a burgeoning population in the millions. The park is located in the heart of San Benito County, however, one of the least populated and most rural counties in California. Large private ranchlands surround the park, and hundreds of thousands of acres of public lands are nearby. Park staff has worked hard to build understanding and support for the condor reintroduction program with neighboring landowners and surrounding communities through ongoing education and outreach.

A successful condor reintroduction at Pinnacles will, of course, be only a piece of the larger strategy for recovery of this remarkable species, including numerous federal and state agencies, and private and nonprofit organizations. Release is just the first step in the ultimate success of the condor program. Once condors are again soaring over Pinnacles, they will face numerous hazards and challenges, both natural and human-related. Predators such as coyotes and golden



An adult condor named Hoi, distinguished by his pinkish-orange head and neck (above), lived with the six juvenile birds, teaching them skills needed for survival in the wild.

eagles pose a moderate risk to the birds' survival. Much greater is the danger posed by humans. The preeminent threat to condors is lead poisoning, caused by consumption of lead-contaminated carcasses or gut piles left behind by hunters. Few people are aware of the danger lead poses to condors, or of the solutions that could overcome these hazards. These threats can be mitigated through the use of lead-free ammunition or burying animal remains, and a comprehensive educational effort is a focus of all agencies and organizations engaged in the condor recovery program. Collision with utility lines is another danger to condors because they have difficulty seeing them. Small, inexpensive diverters have been used effectively in release areas to make the lines more visible. Despite these and other obstacles, successful recovery of the species is possible. Captive-bred condors fledged a chick this fall in the Grand Canyon, the first wild fledgling of this species in the wild since the mid-1980s, and a milestone in the overall condor recovery effort.

Ultimately, bringing the condors home to western North America will depend on an informed and engaged public committed to their return. The staff at Pinnacles welcomes the opportunity to serve as a critical link in the recovery effort. ■

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Reproduction of Canada lynx discovered in Yellowstone

By Tiffany Potter



Yellowstone National Park, Wyoming, has confirmed the presence of a female Canada lynx and her kitten in the central portion of the park. Staff members of the Yellowstone lynx project were jubilant when, with a snowstorm looming, they located snow tracks of a lynx and her cub on an extremely cold day (below -20°F , -29°C) in February 2003. A goal of the lynx project is to determine if Yellowstone

has a resident population of this elusive animal, and this discovery suggests that the animals are resident rather than transient.

With more than 50 pounds of survival and tracking gear, biologists on skis followed the tracks for 2.2 miles (3.5 km), measuring tracks, taking plaster casts, and collecting hair and fecal samples for

“This discovery is the first documented case of reproduction of lynx in Wyoming since 1998.”

DNA analysis. Scientists at the University of Montana's Rocky Mountain Research Laboratory extracted DNA from the samples and identified the source of the hair and scat as lynx. The Rocky Mountains Cooperative Ecosystem Studies Unit has an agreement with the genetics laboratory to identify species and gender of forest carnivores from hair and scat samples submitted by the National Park Service. The presence of Canada lynx was first recorded from DNA from hair snared in summer 2001; however, questions remained as to whether lynx were visitors to or residents of Yellowstone.

This discovery is the first documented case of reproduction of lynx in Wyoming since 1998. In the summer, reproduction was also documented in six lynx females that were reintroduced to southwestern Colorado. These reproducing lynx represent an important success for this species, which is listed as threatened across its range in the contiguous United States. Scientists still have questions about the long-term survival of lynx offspring and their ability to be recruited into the population. Documenting a small population of lynx in Yellowstone could be an impetus for additional study. ■

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Dragonflies and damselflies: Invertebrate indicators of ecological health

By Carol DiSalvo, Richard Orr, and David Foote

INVERTEBRATES, magnificent spineless creatures that few people ever ponder in a positive way, constitute the bulk of biological diversity on Earth and in our national parks. They dominate every global ecosystem in terms of species richness, biomass, and ecological function and are the foundation of every food chain, inhabiting niches from caves to the Arctic. Invertebrates play essential and remarkably diverse roles as decomposers, food sources, herbivores, dispersal agents, and pollinators. And they are important indicators of ecosystem health.

Despite their importance and abundance, invertebrates have been largely overlooked. Research focusing on this huge taxonomic group has been poorly funded compared with the study of more charismatic species such as mammals, birds, and fish. Fortunately, the critical importance of invertebrates is finally being acknowledged thanks to brilliant ecologists and enthusiasts such as E. O. Wilson and a handful of exceptional and pioneering natural resource managers of the Department of the Interior. These stewards are demonstrating how surveys of invertebrates can help park managers evaluate and detect change in ecosystem health and biodiversity.

Dragonflies and damselflies, of the order Odonata, are well-known invertebrates and are of great ecological importance. The odonates comprise a significant animal component of aquatic environments. As insect predators low in the food chain, odonates reflect changes in the health of aquatic ecosystems much faster than can be recognized through monitoring most other animal or plant groups. Using these

indicator species in baseline surveys provides a measure of the current health of the various aquatic systems in a park and is an excellent monitoring tool for predicting future changes in those environments.

Furthermore, information on the presence and function of damselflies and dragonflies in national parks is important if an ecosystem approach to management is to be successful. Yet, to date, only a handful of parks have begun this type of monitoring.

Eastern North America is one of the global hot spots of dragonfly biodiversity and an ideal region for realizing the potential of monitoring odonates. One of the first surveys of this type is occurring at Harpers Ferry and C&O Canal National Historical Parks, and Rock Creek Park. Increasing concern about the consequences for nontarget species of proposed insecticide used to combat West Nile Virus has led resource managers to initiate a three-year study of odonates. The survey has begun to describe the distribution and abundance of species, including those that are rare, threatened, or endangered. This baseline information may help delineate risks and avoid unnecessary insecticide treatments. Odonates are the most common and conspicuous animals around the aquatic wetlands of the three parks, and more than 90 species were identified in the first field season of the survey. This includes a number of state-listed species and the first location of viable populations of mocha emerald and clamp-tipped emerald dragonflies (*Somatochlora linearis* and *S. tenebrosa*, respectively) in the District of Columbia. Although the study is not complete, scientists expect that additional state- and district-listed rare or threatened species will be found.

In the West, Carlsbad Caverns National Park announced in July the discovery of a rare damselfly, *Argia leonorae*, not previously known in New Mexico. A University of Texas biology class led by John Abbott made the discovery. Abbott and his students found a single adult male, which is blue in color. Known as Leonora's dancer, it is named for Leonora Gloyd, who studied North American damselflies for 50 years. This species was federally listed as rare in 1996 and is thought to be extirpated from its only population in Texas, 100 miles south of the park, because of habitat changes.

The Hawaiian Islands host 36 species of odonates, including an entire genus of 25 damselflies (*Megalagrion* species) that are unique to the islands. The two endemic Hawaiian dragonflies, the Blackburn dragonfly (*Nesogonia blackburni*) and the giant Hawaiian dragonfly (*Anax strenuus*), are common to remote montane forest streams. In contrast, a number of the *Megalagrion* damselflies have become rare, especially in lowland habitat. Six of these *Megalagrion* species are under consideration for listing under the Endangered Species Act.

The Hawaiian damselflies represent a remarkable instance of ecological diversification during their evolution on the islands. Some *Megalagrion* damselflies are found at traditional breeding sites such as stream edges and freshwater pools, but others occur in very unusual settings. For instance, many breed on freshwater seeps that flow across moss-covered rocks well above a stream, in some cases along the edge



The larval *Megalagrion koelense* damselfly (above) perches on the leaf of a native Hawaiian lily where it completes its life cycle by preying on other insects.



The Hawaiian damselfly *Megalagrion koelense* (adult male depicted, left) breeds in leaf pockets of native lilies.

Hawaiian damselflies *Megalagrion calliphya* perch on emergent aquatic vegetation (below). The red male holds on to the green female while she inserts eggs into the plant stem.



of waterfalls. Even more amazing are two semiterrestrial species that have abandoned streams altogether and breed in water that collects in the bases of leaves of climbing vines and lilies. The larvae use these small pockets of water to capture and feed on other insects and small snails. The most extreme case is the completely terrestrial *Megalagrion oahuense*, a Hawaiian damselfly that has abandoned not only the streams but also the leaf pockets. Its hairy larvae live in damp leaf litter under banks of uluhe ferns in the wet upper-elevation rainforests on the island of Oahu. This species has completely lost the ability to breed in water.

The diversity of breeding habitats among *Megalagrion* damselflies has recently been used by researchers with the U.S. Geological Survey at Hawaii Volcanoes National Park. USGS ecologists are measuring how communities of damselflies change in response to moisture stress and temperature change. They are observing systematic shifts in damselfly community composition associated with changing hydrologic conditions. In this way, Hawaiian damselflies are serving as a focal group to better understand the consequences of long-term climate change.

Major threats to Hawaiian damselflies include habitat degradation and alien species introductions. Lower- and mid-elevation aquatic habitats are often invaded by alien fish that prey on the damselfly larvae. On Oahu, the endemic orange-black damselfly (*M. xanthomeles*)

is a proposed threatened species and the focus of ongoing conservation efforts. It is being restored to low-elevation breeding sites that are free of alien fishes, and is also being studied at Kaloko Honokohau National Historical Park on the island of Hawaii, where the species breeds in rare coastal pools that are threatened by upslope industrial development. This is another example of how *Megalagrion* can serve as sentinels of ecosystem health in a wide range of unique habitats in national parks of Hawaii.

The odonates are important ecological, scientific, and educational park resources. Information from inventory and monitoring applied to management practices will reduce risks to odonates and other invertebrates and their habitats. In addition, this information is valuable for addressing threatened and endangered species issues and the conservation, planning, and management of freshwater aquatic ecosystems. ■

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award-winner

Doug Smith heads wolf restoration project

For his leadership in the restoration of the gray wolf in the northern Rocky Mountains, Dr. Doug Smith received the Director's Award for Natural Resource Management. As Wolf Project leader, Doug has played a major role in the success of this venture. (See *Natural Resource Year in Review—2001*, page 51.) This project serves as a model for how to restore, manage, monitor, and live with a large predator, and has far-reaching implications for the restoration of wildlife worldwide.

When the wolves were first brought from Canada in 1995 and 1996, Doug managed their care in the acclimation pens and has continued to do so since their release, developing procedures to restrict human use around active wolf dens, managing nuisance wolves outside the park, and investigating wolf fatalities. Monitoring wolves is difficult but crucial to this project. Doug devised innovative long-term wolf monitoring and research procedures. His winter study strategy has allowed investigators

to closely observe wolves making kills and interacting among themselves and with other species. These data have led to the development of statistical methods for estimating how often wolves kill large prey.

Armed with this kind of information, Doug and fellow project advocates can rebut charges from angry opponents of the project that the wolves are decimating the elk herds, and that their population is exploding. His many outreach activities are important for winning support and raising funds. He is an educator about wolves, making presentations to lay audiences, teaching wildlife education courses, mentoring graduate students, and contributing articles to journals and books. He has integrated more than 150 volunteer scientists into the park's management and research programs, and through the Yellowstone Visiting Scholars Program has welcomed wildlife biologists from around the country and abroad.



Dr. Doug Smith receives the Director's Award for Natural Resource Management from Dr. Lee Talbot, a coauthor of the Endangered Species Act, and Yellowstone Center for Resources Director John D. Varley.

Growing up in rural Ohio, Doug says, "My interest in nature and remote places was nurtured by my father and then focused on wolves when my brother bought me the classic book *The Wolf* by L. David Mech," prompting him, at age 16, to write Mech asking for a job. Now, a few decades later, young people are contacting Doug with aspirations of working with wildlife in remote places. ■

Tracking bull trout in Olympic National Park, Washington

By Samuel J. Brenkman and Stephen C. Corbett

THE MIGRATORY PATTERNS of bull trout (*Salvelinus confluentus*) are the focus of an ongoing three-year study in the Hoh River of Olympic National Park in Washington. The bull trout is a member of the salmon family, related to Pacific salmon, trout, and Dolly Varden. Though the bull trout has declined throughout most of its historical range and is federally listed as threatened, its status and biology in national parks within its range remain largely unknown. Research in the last decade reveals that declines in distribution and abundance are due to degradation of freshwater habitats, overfishing by recreational anglers, hydroelectric dams, irrigation projects, and displacement by nonnative fish species. Olympic National Park contains some of the last remaining undisturbed habitat throughout the entire range of bull trout. However, bull trout in the park have been negatively influenced by land-use activities adjacent to the park boundary coupled with mortality associated with recreational and tribal fisheries directed at Pacific salmon and steelhead.

One critical question related to the life history of bull trout is whether populations with access to the ocean exhibit diadromy, or migration between freshwater and marine environments. The potential for diadromy in bull trout exists in large, free-flowing river systems that originate in Olympic National Park. In the current study, radiotelemetry was used to determine migratory patterns of adult bull trout in the Hoh River Basin. The primary objectives were to determine seasonal movements of adult bull trout, location and timing of spawning, use of estuarine and marine waters, and extent of use of tributary streams.

Unlike Pacific salmon, bull trout

- Live longer—13 or more years
- Exhibit light-colored spots on a dark body
- Prey primarily on other fish species
- May spawn multiple times throughout their life history
- Exhibit nonmigratory and migratory life history forms
- Are more elusive and secretive (juveniles are observed mostly at night)
- Require the cleanest and coldest water of any salmonid in North America

From July 2002 to June 2003, a total of 82 adult bull trout, ranging from 16 to 28 inches long (40 to 70 cm), were captured at various locations in the Hoh River, South Fork Hoh River, and Kalaloch Creek; outfitted with radio transmitters; and safely released. Transmitters, each with a unique code allowing individual fish to be identified by their signal, were inserted into the body cavity through a small incision. Movements were tracked using five fixed stations strategically located and evenly distributed throughout the watershed. Each station includes two directional antennas, a receiver, and amplifiers that detect

upstream or downstream movements of individual fish. In addition, fish were tracked weekly by boat or from the riverbank and biweekly from the air, covering 62 miles (100 km) of the Hoh River and its tributaries, 155 miles (250 km) of the Pacific Coast, and the lower portions of numerous coastal rivers and creeks.

Bull trout implanted in the Hoh River exhibited complex seasonal movements. In the first year of the study, three general patterns of movement emerged: (1) upstream migration during the presumed spawning period from September to November; (2) downstream movement into the lower river followed by prolonged periods of residence;



Federally listed as a threatened species, bull trout in the Hoh River Basin of Olympic National Park have been shown to migrate in complex patterns that include moving from freshwater to marine environments. These preliminary research findings suggest potential vulnerability to recreational and gill-net fisheries that target salmon and steelhead.

and (3) emigration by 51% of implanted fish downstream into the estuary, the Pacific Ocean, and for some fish, into the lower reaches of other coastal rivers and streams outside the Hoh Basin.

Radiotelemetry has proven to be an effective method to determine movements of adult bull trout in logistically difficult terrain. This investigation provides the first information on bull trout migrations in a largely unaltered coastal river and the first verification of diadromy for the species. Initial data on seasonal movements and habitat use identify potential vulnerability to recreational and gill-net fisheries that target salmon and steelhead throughout the year. Bull trout may be susceptible to incidental harvest based on the following life history attributes: (1) extensive movement to and from saltwater and entry into multiple rivers where fisheries exist; (2) timing of outmigration from December to March and entry into the river that coincides with salmon and steelhead harvest seasons; and (3) longevity and capacity for repeat spawning, which increase the number of possible encounters with fisheries. The effects of fishing mortality at the population level remain unknown. The final report for this study will provide in-depth analysis of migratory patterns, habitat use, spawn timing and location, and effects of harvest, leading to the establishment of appropriate conservation and recovery strategies for this species. ■

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Restoring federally endangered harperella along waterways in the National Capital Region

By Elizabeth Fortson Wells and Dianne Ingram

IRREVOCABLE CHANGES in the hydrologic cycles of eastern rivers and streams have imperiled harperella (*Ptilimnium nodosum*), a small member of the carrot family. Federally listed since 1988, harperella is the only endangered plant species in the National Capital Region. Over the past 90 years, harperella populations have been located, and subsequently extirpated, three times in the Chesapeake and Ohio Canal National Historical Park (Maryland). The park, which provides historical and potential habitat for harperella, experiences annual floods that may cause two extreme changes: “founder” events and extinction events. That is, new harperella populations are established while local populations become extinct. These dynamic founder-extinction events make watershed-level conservation necessary for this species.

In 2001, park managers initiated restoration and recovery efforts for harperella by surveying for extant populations and collecting seeds. In 2002 the lead scientist on the restoration project, Dr. Elizabeth Wells, began germination and seedling-growth experiments using harperella seeds collected from neighboring lands. During these successful experiments, germination took place at moderate temperatures over two to three weeks.

In summer 2003, Wells began characterizing and searching for suitable riparian habitat to reintroduce harperella populations. Harperella has very particular site requirements, specifically gravel bars that have full sun during most of the day, which few areas on parkland meet. Gravel bars simultaneously offer protection from

severe erosion while receiving occasional scouring events. The plant requires a narrow range of water depths (neither too deeply submerged nor too high above the water) during critical parts of the growing season. As disturbed and scoured areas, the bars also provide suitable habitat for exotic species.

“Dynamic founder-extinction events make watershed-level conservation necessary for this species.”

The Exotic Plant Management Team from the National Capital Region has been instrumental in this restoration effort. At selected planting sites, team members mapped vegetation, classified species, and helped prepare the sites for planting by removing aggressive exotics such as Japanese knotweed (*Polygonum cuspidatum*).

During periods of low water in July and August 2003, which corresponded to natural seed drop by harperella in the area, Wells planted viable seeds into five plots at selected sites along the Potomac River. Extensive flooding occurred within a few days after planting and possibly washed away the seeds as no seedlings sprouted in the plots. Therefore, in late October, restoration efforts required transplanting five seedlings from the germination experiments into each plot and individually staking the seedlings with biodegradable cloth.

The small white clusters of carrotlike flowers show harperella in full bloom on a site near the Chesapeake and Ohio Canal National Historical Park. Harperella is the only federally endangered plant species in the National Capital Region.





Dr. Elizabeth Wells (above left) and her assistant, Charlotte Marvil, lay out a plot for planting harperella on a gravel bar beside the Potomac River in C&O Canal National Historical Park. The plots are marked with 14-inch (35-cm) long

spikes and biodegradable flagging tape, using orange twine to crisscross the space about 8 inches (20 cm) above the surface.

Scientists do not fully understand the consequences of flooding during various stages of harperella's life cycle. Harperella tolerates or even requires some flooding during the winter and spring to deter weedy competitors from establishing populations on the gravel bars. However, flooding during seed maturation in late summer and autumn, when flower and fruit production occurs, has mixed consequences. By establishing and augmenting new populations downstream, minor floods of low volume appear to have significant, beneficial roles in seed dispersal in autumn. However, major floods of extended duration during autumn appear to obliterate the seeds. The typical three- or four-month period of flowering and fruiting from August until frost usually allows many opportunities for seed dispersal. Unfortunately, this year was notable for frequent massive

floods, including the September 18, 2003, flood that accompanied Hurricane Isabel. Field observations in 2003 suggest that harperella germination and establishment do not occur when water levels are unusually high, whereas vegetative reproduction may be favored during periods of extended flooding. Experiments are planned to test vegetative reproduction in harperella in 2004. ■

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Donna Shaver returns to the National Park Service

Sea turtle biologist Donna Shaver returned to the National Park Service in October 2003 following a 10-year stint with the Biological Resources Division (BRD) of the U.S. Geological Survey (USGS). Shaver was transferred to the National Biological Service when it was established in 1993 along with approximately 200 NPS research-grade scientists and support staff and was later folded into USGS-BRD. Her "restoration" is one of just a few transfers of BRD research scientists back to the National Park Service and results from the USGS determination that Shaver's work is now at an applied state that better fits the park mission.

Shaver is the foremost expert on endangered Kemp's ridley sea turtles in the United States and a leader in sea turtle biology and recovery. She will continue the sea turtle research, monitoring, and conservation efforts that she helped pioneer at the park more than 20 years ago and continued to perfect while working for the USGS. Starting as a Student Conservation Association research associate in 1980, Shaver worked her way up to research biologist in 1993, and completed her doctorate in biology at Texas A&M University in 2000. Mike Soukup, NPS Associate Director for Natural Resource Stewardship and Science, considered Shaver's return very important in reestablishing the institutional knowledge and expertise of the successful sea turtle restoration program in the National Park Service. Shaver now serves as chief of the Division of Sea Turtle Science and Recovery at Padre Island National Seashore.



Sea turtle biologist Donna Shaver and former park superintendent Jock Whitworth release green sea turtle hatchlings at Padre Island National Seashore. Let go just 48 hours after hatching, the sea turtles immediately head to the surf, perhaps not to return to the park to nest for 30 years.

Padre Island is the site of a long-term effort to restore a nesting population of Kemp's ridley sea turtles, the most endangered sea turtles in the world. In a grand, international experiment from 1978 to 1988, Mexican biologists collected eggs from the species' primary nesting beach in Rancho Nuevo, Mexico; packed them in Padre Island sand; and shipped them to the national seashore. After hatching in captivity, the young turtles were released in hopes that they would imprint on the park and eventually return to nest. Shaver arrived two years after this project began and has been integral in shaping the course of the restoration since that time. After 10 years of searching, Shaver confirmed in 1996 the first returning Kemp's ridley sea turtles from the experiment. Eggs continue to be collected in Texas and are incubated at a temperature that encourages more females than males, a strat-

egy that she uses to help increase the number of breeding females and better match the natural sex ratio. Although the Kemp's ridley is still considered endangered, the Padre Island population has increased gradually. In 2003 a record 38 Kemp's ridley nests were documented in Texas, including 23 at the national seashore. Additionally, 55% of all Kemp's ridley nests recorded in the United States since 1989 have been at Padre Island National Seashore. The program now involves up to 20 nonpermanent NPS employees and 100 volunteers each year and is of high interest to locals, scientists, environmental groups, government bureaus, and the media. Based on her excellent work, credibility, and partnership building, Shaver has successfully attracted approximately \$2.6 million to the sea turtle program.

Shaver continues to coordinate research and restoration activities with many partners in the United States and Mexico. She is Texas coordinator of the Sea Turtle Stranding and Salvage Network, a member of the Kemp's ridley sea turtle working group and the Kemp's ridley recovery team, a board member of the International Sea Turtle Society, and a member of the IUCN (the World Conservation Union) Species Survival Commission—Marine Turtle Specialist Group. The National Park Service is proud to welcome her back. ■

Regulations help endangered sea turtles make a comeback

By Darrell Echols and Ed Kassman

IN WHAT HAS NOW BECOME a familiar south Texas rite of spring at Padre Island National Seashore, “turtle patrollers” mount their ATVs and comb the beach for nesting Kemp’s ridley sea turtles, the most critically endangered sea turtle in the world. From the 1950s to the 1980s, humans caused the population of Kemp’s ridley sea turtles to decline nearly to the point of extinction. Through a remarkable international effort involving Mexico, the National Marine Fisheries Service, and the National Park Service, the turtles are making a comeback.

“A key right associated with mineral ownership is that of reasonable access across the surface to explore for, develop, and transport the oil and gas resources.”

A challenge in protecting their nesting sites is ensuring that heavy equipment being shuttled up and down the beach by oil and gas operators en route to production sites does not crush the turtles, their nests, or hatchlings, or impede hatchlings from getting to the ocean. Oil and gas rights existed at Padre Island long before Congress created this unit of the National Park System, and these rights are still held by private entities and the state. However, the park has skillfully applied regulations and well-tailored mitigation techniques to oil and gas operations, playing a key role in the Kemp’s ridley’s recovery.



Endangered Kemp’s ridley sea turtle numbers gradually continue to climb at Padre Island National Seashore. A key to this success has been the efforts of NPS turtle patrollers to locate nest sites (right) so that heavy equipment being shuttled up and down the beach by oil and gas operators en route to production sites does not crush the turtles, their nests, or hatchlings, or impede hatchlings from getting to the ocean. Another important mitigation measure is heavy equipment convoys led by NPS turtle patrol escorts (left).

A key right associated with mineral ownership is that of reasonable access across the surface to explore for, develop, and transport the oil and gas resources. If the National Park Service denied all surface access to the mineral rights holders, the United States would be required to purchase the mineral rights at fair market value. So, despite Padre Island National Seashore’s designation as a unit of the National Park System, and the United States’ ownership of the surface interest, mineral resources are still being developed in the unit.

Regulations promulgated in 1979 require that operators have a National Park Service–approved plan of operations, which will include resource protection measures, provide a reclamation plan, and file a suitable performance bond. Through this requirement the National Park Service can proactively ensure that operators avoid or mitigate expected impacts on park resources and values.

To protect the nesting Kemp’s ridley, for instance, an operator is required to comply with the following partial list of mitigation measures at Padre Island National Seashore:

- Operator’s employees and contractors must attend an NPS turtle training and awareness course, which includes identification of turtle tracks, a notification protocol to follow in the event that turtles or nesting grounds are located, and marking the location of tracks or nests if an employee or contractor is unable to stay on-site until official crew members arrive.
- During peak Kemp’s ridley nesting season, operators’ vehicle convoys will not leave before an NPS turtle patrol inspects the beach ahead of them and notifies operators that larger vehicles can travel the beach safely.



- ATVs and large trucks must drive no faster than 15 miles per hour.
- Trucks are required to drive above the “wet-line” on the beach so that turtle tracks can be identified.
- A backhoe or tractor must be stationed on the beach to smooth out ruts after having a monitor on an ATV check for nesting turtles or tracks.
- Larger vehicles are prohibited from traveling at night to minimize impacts on night-nesting turtles, which include the green, logger-head, hawksbill, and leatherback.

With these mitigation measures the park has successfully protected Kemp’s ridley nests. It has never documented a hatchling death, death of a nesting sea turtle, or crushing of a sea turtle nest by an oil and gas operator since the program began 25 years ago. In addition, the Kemp’s ridley population has slowly but steadily increased since the mid-1980s.

Although it is certain that the absence of mineral development at Padre Island National Seashore would lower the risk to the Kemp’s ridley’s recovery, the park has succeeded in fulfilling Congress’s directive to manage resources while recognizing the rights of mineral operators to access the surface and develop their property interest. ■

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Oil and gas management plan for Padre Island National Seashore upheld in court

By Darrell Echols and Ed Kassman

On April 17, 2002, the Sierra Club filed suit in federal district court in Texas against the Secretary of the Interior, the National Park Service, and the U.S. Fish and Wildlife Service. The Sierra Club’s complaint alleged that the National Park Service violated section 7 of the Endangered Species Act when it prepared its oil and gas management plan and also when it approved two private oil and gas operations. Specifically, the Sierra Club claimed that the Park Service was not adequately protecting Kemp’s ridley sea turtles, a federally listed endangered species. The district court ruled in favor of the National Park Service, holding that the oil and gas management plan was not subject to judicial review and that the Park Service had acted reasonably when it approved operations at the two well sites. The court also noted that the Park Service has required the company drilling the wells to adhere to extensive mitigation to protect the turtles (see page 92). The Sierra Club appealed to the Fifth Circuit Court of Appeals, which affirmed the lower court’s decision. No appeal to the Supreme Court is expected.

Since 1979 the National Park Service has managed the exercise of nonfederal oil and gas rights to avoid or minimize damage to park resources and values. In 1995, private mineral owners at Padre Island National Seashore sued the park in federal district court challenging the park’s authority to regulate the exercise of private mineral rights. In that case, the district court ruled in favor of the National Park Service, and the Fifth Circuit Court of Appeals affirmed the lower court’s determination. The Fifth Circuit’s ruling in the Sierra Club’s most recent challenge further assures Padre Island National Seashore and the National Park Service of the effectiveness of regulatory authority regarding private oil and gas activities to protect all park resources, including the endangered Kemp’s ridley sea turtle. ■

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Cooperative Conservation

“Management of landscapes that will provide for the long-term well-being of both natural populations and human populations requires the cooperative efforts of all who live in and manage that landscape.”

—William L. Halvorson
National Parks and Protected
Areas: Their Role in
Environmental Protection

Partnerships have become an essential tool for carrying out the mission of the National Park Service. Park managers are increasingly working with neighboring communities, state and federal agencies, corporations, nongovernmental organizations, and universities to deal with a wide range of issues and maximize limited resources. For example, they understand that effectively addressing watershed management and protection, the spread of exotic plants and animals, or the recovery of endangered or declining species involves working cooperatively with myriad partners, from state agencies and private landowners to university researchers and committed volunteers. In addition to tackling resource threats coming from outside park boundaries, managers seek partnerships with other institutions and individuals to realize the unparalleled value of the parks for learning and scientific research. Partnerships also recognize that “two heads are better than one,” and as the articles in this chapter demonstrate, frontline park managers are developing the expertise to build successful long-term relationships that result in tangible benefits to both the parks and their partners. The administration also values the vitality of cooperative efforts for resource protection; in 2003 it launched the Cooperative Conservation Initiative, ushering in a new era for partnerships in the parks. The parks play an essential role in the social and economic fabric of the nation, and partnerships for cooperative conservation are an explicit recognition of this evolving reality.

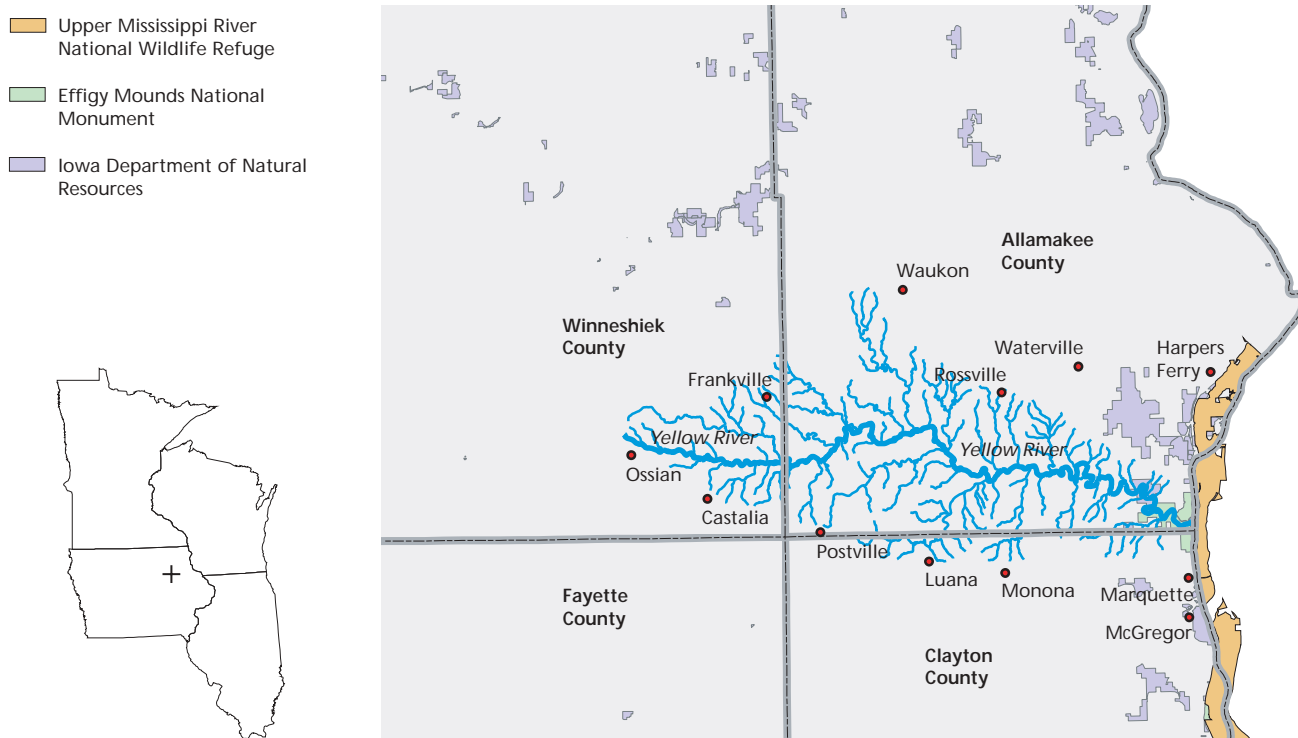
Effigy Mounds National Monument is located in the Yellow River watershed in northeastern Iowa, where the National Park Service and other government agencies and nongovernmental organizations are cooperating to develop a model in which local leadership is educated and empowered to steward natural resources and sustain a healthy environment.



The Yellow River Initiative: A partnership for resource sustainability

By John H. Sowl

YELLOW RIVER WATERSHED



THE NATIONAL Park Service's Midwest Region has played an important role in a demonstration project called the Yellow River Initiative, undertaken by the Midwest Natural Resources Group (MNRG), a federal interagency partnership. This initiative is intended to develop methodologies whereby all stakeholders in a watershed cooperate to protect and conserve its natural resources in balance with the ongoing human needs of the area. The Yellow River watershed was selected for this project because of its manageable size and diverse landscape components, and because six federal agencies have a physical or active programmatic presence. The National Park Service has been charged to provide both overall administrative and local coordination of this project through Effigy Mounds National Monument (Iowa).

The Yellow River watershed is located in northeastern Iowa's unglaciated "driftless area." This 154,666-acre (62,640-ha) watershed has diverse topographic and natural resource features, along with a variety of resource-related problems similar to those found throughout the watersheds of most tributary streams feeding into the Upper Mississippi River. Situated within a karst region, approximately 90% of the Yellow River's flow comes from groundwater. The watershed is a

"This initiative is intended to develop methodologies whereby all stakeholders in a watershed cooperate to protect and conserve its natural resources in balance with the ongoing human needs of the area."

diverse, mostly agricultural landscape of incised valleys and rolling uplands. Significant natural habitat exists in the watershed, particularly within its lower reaches where Effigy Mounds National Monument is located. Due to the rugged topography and drainage pattern of this portion of the driftless area, small rural communities are situated almost exclusively along the outer fringe of the Yellow River watershed.

Members of the Yellow River Initiative include agencies at the federal, state, county, and conservation district levels as well as non-governmental organizations and individuals. Procedures to accomplish the goals of the initiative will be developed through collaboration among the partners. Participants have accepted the challenge to keep

the end products of this effort “simple, practical, and understandable” for everyone.

The goals of the Yellow River Initiative are:

1. to assess the natural resources within the Yellow River watershed, based on existing information, and determine their extent, distribution, and condition;
2. to identify, in light of the assessment, possible options to promote the long-term sustainability of the watershed’s natural resources; and
3. to develop an Internet-based “toolbox” of technical assistance information, “hotlinks” to appropriate existing resource sites, and contacts to help the public implement these options.

Scientific data and other information are now being gathered from partners, regional universities, and other sources to support watershed resource analysis and the creation of the technical assistance Internet-based “toolbox.” In addition, informal, public open-house meetings have been, and will continue to be, held within the watershed to develop details of the initiative, answer questions, provide opportunities for partnership interactions, and generally encourage public participation in and contributions to the project.

To promote local leadership and ongoing local control of the initiative and its work, a Resource Conservation and Development (RC&D) office within the watershed has been identified as the potential long-term local coordinator after the initiative’s two-year development is completed in early 2005. The National Park Service will continue to provide administrative coordination during the project’s initial

development. The RC&D would then take over coordination, providing information and guidance to assist individuals, landowners, and organizations in promoting voluntary implementation of long-term natural resource stewardship options within the watershed.

“The Yellow River watershed is located in northeastern Iowa’s unglaciated ‘driftless area.’”

At the end of its two-year developmental period, the initiative is expected to result in:

1. development of a methodology that can be applied to other small watersheds;
2. benefits to local residents by providing them with information, including completion of the Internet “toolbox,” so that they feel empowered to be effective stewards; and
3. establishment of voluntary relationships among stakeholders, to promote stewardship of the watershed’s natural resources.

Ultimately, the National Park Service hopes that the Yellow River Initiative will be a practical model for developing local leadership in stewarding a watershed to sustain the health and vitality of its natural resources and its human community. ■

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Web-based communication system eases public review of environmental planning

By Jacob Hoogland

Web-based computer applications have become an essential part of park management. They aid in a variety of important functions, from financial planning and procurement to research permitting and biodiversity inventorying. In addition, nongovernmental organizations and members of the public are making use of Web-based communications (including e-mail) to scrutinize and comment on activities of the National Park Service. Recognizing that these tools could be used to simplify and “automate” the public review of environmental impact statements and other environmental planning documents required by the National Environmental Policy Act and related statutes, the National Park Service initiated a needs assessment in 2000 to determine how best to harness the Internet to meet these obligations. The results of the

assessment were used to develop the Planning, Environment, and Public Comment (PEPC) system.

PEPC is an online collaborative tool designed to support project planning; public comment tracking, analysis, and response; and other public communication efforts. The system was developed in collaboration with park, regional, and other NPS experts working with specialists from Aquilent, a leading provider of Internet solutions for government. The system consists of both internal and external components. The internal system allows NPS employees to track public review milestones, prepare routine documentation and reports online, easily post documents to the Internet, and manage public comments and NPS responses in a paperless environment. The external component of the system

enables the public to determine the status of various environmental planning documents, download copies of these documents, and return comments to the National Park Service.

PEPC is modeled after a system developed by Blue Ridge National Parkway staff. The park initiated the precursor system to integrate facility planning with compliance to avoid delays in funding and construction.

The PEPC system was tested with a group of park users in 2003 and modified to provide additional features. Pilot park testing is scheduled to begin early in 2004, with nationwide use of the system available later in the year. ■

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Ocean resources of the National Park System: Out of sight, out of mind, left behind

By Gary E. Davis

AMERICANS EXPECT their National Park System to comprise unimpaired resources and to exhibit values that represent the nation's heritage in superlative natural, historical, and recreational areas. More than 40 ocean parks, however, currently fail to meet these expectations. National parks afford little or no special protection to nature in the ocean, which surprises many citizens. To address this issue in 2003, ocean park superintendents and other park professionals invited staff from other agencies and organizations to draft an "Ocean Park Strategy." They identified several major issues and recommended ways to address them.

The partners included the National Oceanic and Atmospheric Administration, U.S. Geological Survey, U.S. Fish and Wildlife Service, California State Parks Department, American Fisheries Society, Sport Fishing Institute, Sea Web, The Ocean Conservancy, Environmental Defense, National Parks Conservation Association, Wild Coast, Reef Environmental Education Foundation, Student Conservation

"States regulate ocean fishing in most national parks and do not differentiate parks from surrounding waters."

Association, Partners in Parks, and a dozen universities. To find common ground among participants and develop the strategy, the partners held six regional workshops and four topical workshops on, respectively, marine protected-area science, the political realities of ocean conservation, partnerships and public involvement in ocean conservation, and an action plan to improve coastal conservation in the national parks.

Ocean stewardship is complicated by many factors. Human-driven global forces that alter climate and sea level render concepts of *natural* and *unimpaired* difficult to grasp when considering the ocean. Pollution and invasive nonnative species also threaten ocean parks, but the effects of people removing thousands of tons of fish and other sea life from parks every year far exceed those threats. States regulate ocean fishing in most national parks and do not differentiate parks from surrounding waters. Overfishing that has depleted sea life populations throughout U.S. waters also has depleted fish and sea life in the parks. Consequently, parks have lost fishing and other recreational opportunities dependent on living ocean resources. In addition, the ecological effects of overfishing have permeated parks, dramatically altering entire ecosystems. Flattened, disturbance-adapted sea urchin

Lobster traps become lodged in coral reefs at Biscayne National Park, Florida, as a result of storms. No longer active for lobstering, they continue to trap and kill fish. Newly established reserves in parks will serve as recovery areas that allow a variety of fish and other sea life to grow large, become fecund, and help restore depleted populations.





A coral reef without large fish? Populations of snapper and grouper in national parks of the Caribbean Sea and Florida have plummeted over the past couple of decades. Advances in fishing tackle, fish-finding sonar, and the use of global

positioning systems have enabled fishers to target large fish effectively. One of the concerns of the recently drafted Ocean Park Strategy is unsustainable removal of ocean resources by humans.

barrens, algae-covered rocks, and other diminished communities have replaced diverse and productive giant kelp forests, coral reefs, and seagrass meadows in parks.

The four pillars of park stewardship—*Know, Restore, Protect, and Connect*—provide a simple way to organize the Ocean Park Strategy. As for what to know, the National Park Service needs to increase its capacity

“Overfishing that has depleted sea life populations throughout U.S. waters also has depleted fish and sea life in the parks.”

to explore and understand the ocean realms of parks and to revitalize its scientific and public safety diving program. Park stewards need to better understand ocean ecosystems and human roles in them. They need resource inventories, submarine habitat maps, monitoring, and more clearly defined ocean boundaries and jurisdictions. On land the National Park System plays an important role in national conservation strategy and policy, but in the ocean, relationships with other resource management agencies are not as clear. To restore and protect, the strategy proposes a “Restore Impaired Ocean Park Resources” initiative to address critical restoration issues and to improve park protection. Ocean parks need to assess performance of newly established marine recovery

areas in parks, develop joint fishery management plans with states, prevent extirpation of native species, and establish ocean damage assessment teams.

The critical keys to improved ocean conservation in the National Park Service are partnerships with other ocean-related agencies to facilitate cooperation, collaboration, and communication. But doing a better job of connecting people to ocean parks may be the most important task ahead. The strategy recommends that an ocean park task force coordinate these activities. Such a task force would help resolve misconceptions about the need to change traditional ocean conservation and improve communication among ocean park professionals and with the public. It would also engage artists, students, and volunteers in parks, and raise the National Park Service’s awareness about its ocean responsibilities and opportunities. The Natural Resource Challenge addresses these same kinds of stewardship issues for all parks. The Ocean Park Strategy seeks to focus ongoing Natural Resource Challenge efforts on particular common needs of ocean parks to prevent the nation’s ocean heritage from being left behind. ■

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Cooperative Conservation Initiative celebrates remarkable progress in first year

By Lindsay McClelland

THE COOPERATIVE Conservation Initiative (CCI) is a new program that seeks to strengthen citizen participation in conservation through partnership projects with U.S. Department of the Interior agencies. Congress appropriated nearly \$5 million to the National Park Service in FY 2003, the initiative's first year, to restore natural resources and establish or expand habitat for wildlife in national parks. At least 50% of project costs must be contributed by partners, including neighboring landowners, nonprofit organizations, local and state governments, corporations, and many individual volunteers. The National Park Service supported 74 projects with 200 partners in 2003, generating an additional \$8 million to benefit the parks.

Many CCI-funded projects targeted removal of invasive plants and reestablishment of native species. Melaleuca monocultures once infested 186 square miles (482 sq km) of Big Cypress National Preserve, Florida (see article, page 15). Initial treatment of about 14 million stems was recently completed. To keep the trees from recolonizing, the initiative and the State of Florida are funding hand-pulling and herbicide treatment in two large areas of the preserve. Another CCI project involves fighting three noxious weed species that have recently invaded riparian corridors in Lake Mead National Recreation Area, threatening to replace native vegetation and disrupt wildlife habitat. Project partners Clark County, Nevada, and the Southern Nevada Water Authority will provide matching funds to support the treatment of entire drainages to prevent the spread of these weeds to the whole Colorado River corridor.

CCI supported the expansion of a successful project to reestablish a nesting colony of Kemp's ridley sea turtles at Padre Island National Seashore, Texas, site of more than half of this turtle's documented nests in the United States (see related stories, pages 91–93). The grant will fund additional patrols to locate nest sites, and a new facility capable of incubating more eggs and releasing more hatchlings. Key partners include the Texas Parks and Wildlife Department, Shell Oil Company Foundation, Unilever (through the National Fish and Wildlife Foundation and the National Park Foundation), and more than 100 volunteers. CCI funds were also used to enhance turtle nesting habitat at Cumberland Island National Seashore, Georgia, and Hawaii Volcanoes National Park.

In partnership with the State and City of New York, CCI funds will help start a major restoration of the Jamaica Bay salt marsh in Gateway National Recreation Area, where substantial wetland loss has occurred. After the initial 2-acre (0.8-ha) project is completed, the U.S. Army Corps of Engineers will restore 50 to 75 acres (20 to 30 ha) of salt-marsh habitat. Zoologists with natural heritage programs in Maryland and Virginia have identified four rare invertebrates in Potomac River Gorge springs and seeps within Chesapeake and Ohio Canal National Historical Park and George Washington Memorial Parkway. The seeps suffer from erosion, sedimentation, and toxins from nearby develop-

ment. With CCI funding, the parks and their partners, including American University; Arlington County, Virginia; The Nature Conservancy; and the Potomac Conservancy, will cooperate to restore vegetation buffers, reroute trails, improve parking areas, influence road maintenance practices, and reach out to nearby landowners.

The National Park Service manages some of the nation's most important bat habitat. In cooperation with numerous partners, including Bat Conservation International and U.S. Borax, Inc., CCI will help fund the construction of bat gates that ensure the safety of cave and mine openings in eight parks, while protecting habitat for bat hibernacula and maternity roosts.



Badlands National Park biologists Doug Albertson and Greg Schroeder take a blood sample from a captive swift fox prior to its release in the park.

Poaching eliminated the previously flourishing yellow lady's-slipper orchid from Mammoth Cave National Park, Kentucky. Restoration had been impractical because orchids are difficult to propagate, but scientists have recently learned that orchid seeds can be germinated in the laboratory and then transplanted. A self-sustaining orchid population that can also be a source of plants for restoration efforts in other parks will be established using CCI funding, more than 3,000 volunteer hours, and discounted orchids from the Vermont Ladyslipper Company, which specializes in laboratory-propagated lady's-slipper orchids.

Predator control and habitat change have eliminated the swift fox from most of the Great Plains. In partnership with the Turner Endangered Species Fund and South Dakota State University, CCI has helped to fund reintroduction of these housecat-sized carnivores to Badlands National Park, South Dakota (see article, page 76). Before releasing 30 swift foxes captured in Colorado, project scientists located areas where coyotes, important swift fox predators, are not abundant.

With strong support from the U.S. Department of the Interior and numerous partners, the CCI provides an important new opportunity for habitat restoration and enhancement throughout the National Park System. ■

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Natural Resource Partnership Program continues to grow

By Diana Maxwell

THE NATURAL Resource Partnership Program began in late 2000 as a result of the ever-increasing need to bring additional fiscal and human resources to diverse natural resource field programs in the National Park Service. The program coordinator is cooperatively funded by five divisions in the Natural Resource Program Center (NRPC): Air Resources, Biological Resource Management, Geologic Resources, Natural Resource Information, and Water Resources Divisions. These divisions have numerous successful partnerships in place and program center staff members often collaborate with parks on projects, including the Geoscientists-in-the-Parks Program. The need for a formalized partnership effort evolved as park requests for technical assistance through the Natural Resource Challenge demonstrated a clear need for increased expertise in accomplishing important natural resource projects.



Members of the Environmental Alliance for Senior Involvement (EASI) visited Rocky Mountain National Park, Colorado, during the summer to learn about a variety of volunteer opportunities with the park. The EASI Natural Resource Laureate Program places experienced natural resource professionals in national park units to accomplish scientific work that might not otherwise be produced.

The goal of the program is to develop new and enhanced partnerships that will expand the NRPC technical support base and increase the number of natural resource projects in parks. The program has evolved in scope by forming partnerships with new organizations. This year proved to be successful for beginning new programs and for making progress with “maturing” projects.

The partnership program teamed up with the Sonoran Institute, Bureau of Land Management, Colorado Rural Development Council, U.S. Fish and Wildlife Service, USDA Natural Resources Conservation Service, USDA Forest Service, and Partnership Architecture, LLC, to develop a website for federal employees and the public to find new research and funding opportunities. The Conservation Assistance Tools (CAT) website is a user-friendly method for searching many databases for grant information. These partners have also produced a new brochure describing the benefits of the website. The long-term

goal is to find additional funding and expertise to improve CAT so that it will be of great assistance to park managers who need financial support for natural resource management projects. In November the Sonoran Institute announced that the Red Lodge Clearing House, an organization created by the Liz Claiborne–Art Ortenberg Foundation, will take over the development and funding of this promising program. The CAT website address is www.sonoran.org/cat.

In 2002 the Natural Resource Partnership Program began a relationship with the Environmental Alliance for Senior Involvement (EASI). Named the Natural Resource Laureate Program, this new program places experienced natural resource professionals in national park units to accomplish needed scientific work that might not otherwise be produced. In 2002 a pilot test of the laureate program was announced to parks, who submitted 47 requests for lau-

“The goal of the program is to develop new and enhanced partnerships that will expand the NRPC technical support base and increase the number of natural resource projects in parks.”

reate candidates. Initial placements began in September 2003 and will continue throughout 2004. Pilot programs are running at Richmond National Battlefield Park, Biscayne National Park, Timucuan Ecological and Historic Reserve, the Appalachian National Scenic Trail, and San Juan Island National Historic Site. Another goal of the program is to develop a database of natural resource specialists who can assist parks as needs arise. ■

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NPSFACT

The National Park Service holds one or more active memorandums of understanding with 11 countries: Argentina, the Bahamas, Canada, Chile, China, Gabon, Hungary, Italy, Mexico, Poland, and Venezuela. One of the **most important aspects** of the agreement between the United States and Mexico is empowering **local land managers from both countries to exchange information and work together**. Because of this, scientific and technical exchange and coordination on natural resource management have increased among staff and managers of the natural protected areas.

Steve Chaney's successful efforts to protect dune ecosystem recognized



The Director's Superintendent of the Year Award for Natural Resource Stewardship went to Steve Chaney, superintendent, Great Sand Dunes National Monument and

Preserve, Colorado. Steve's accomplishments at Great Sand Dunes crown a distinguished career in natural resource management in the National Park Service that includes membership in the initial class of NPS resource management trainees in the early 1980s. His leadership resulted in legislation that created the 42,000-acre (17,010-ha) Great Sand Dunes National Preserve, expanded the Great Sand Dunes National Monument to about 108,000 acres (43,740 ha) and authorized its designation as a national park, and created a new 90,000-acre (36,450-ha) national wildlife refuge. When the land acquisition is complete, the preserve will be a unit of the National Park System in which hunting is permitted and the previously designated monument, plus the newly acquired properties, will become a

national park. These two units combined will be the Great Sand Dunes National Park and Preserve. This legislation provides permanent protection for the entire Great Sand Dunes system whereas the original monument boundary encompassed only the high dunes and left out the surrounding sand deposits and watershed elements of the ecosystem, which are critical to its long-term protection.

Passage of this legislation required extensive coalition building with county commissioners, chambers of commerce, private organizations, federal and state agencies, and Congress. Once the land purchase was authorized by Congress, the process of purchasing the land began, involving complex negotiations with many neighbors. The prize for all of this work is that boundaries were drawn on an ecosystem basis, rather than a political basis, placing the entire resource system into a protected status, and creating a huge outdoor laboratory. "Included in this system," Steve says, "is an incredible diversity of resources ranging from pristine tundra to desert environments. The area includes towering 13,000-foot [3,965-m] peaks; sparkling

lakes and streams; forests of pinyon, juniper, spruce, fir, ponderosa pine, aspen, and cottonwood; alpine wildflowers; verdant wetlands; and, of course, the continent's tallest dune field."

To study these widespread resources, Steve has been instrumental in expanding the park's natural resources program. Several species inventories are in progress and more are planned, as is vegetation mapping. Researchers will be accommodated in a new building designed by park staff that includes natural resource staff offices, laboratory facilities, and bunk space for visiting scientists.

In addition to managing his park, Steve is active in helping other parks. Among his activities is membership in the Intermountain Region Natural Resources Communication and Advisory Team where he has chaired efforts to revise the region's procedures for developing and prioritizing resource management funding proposals, in particular to assist smaller parks, and in general to make the entire region more competitive in obtaining support for natural resource research and management. ■

Greg McGuire stewards his park and more



"Thirty years ago, my next-door neighbor had this job and brought me in as seasonal help. Then he retired and a few years later I got his job," says Greg McGuire, facilities

manager at Fort McHenry National Monument and Historic Shrine, Maryland. He does that job very well, receiving the Director's Award for Excellence in Natural Resource Stewardship through Maintenance both for adopting energy-efficient and environmentally sensitive practices at his park and for significantly enhancing the surrounding landscape.

Greg's biggest accomplishment was spearheading the cleanup of the tidal wetlands adjacent to the park (featured in *Natural Resource Year in Review—2002*, page 75).

"It was a hideous debris pile," he says, on state-owned land. After a media campaign that Greg instigated, the state called in a contractor to do the cleanup, but the contractor requested \$250,000 just to build a road into the site. Greg told the state, "I'll do the job for \$25,000." To get the job done, Greg created an innovative partnership with the National Aquarium in Baltimore and then presented the project to the public. A large corps of volunteers, including individuals, government agencies, industry, and nonprofits, removed hundreds of tons of debris and invasive vegetation. The eyesore is gone and wetland wildlife is now returning.

At the park, buildings and vehicles have been retrofitted for maximum energy efficiency. Greg was a leader in working out a Green Energy contract with Constellation Energy Group that made it possible to install photovoltaic lighting throughout the park and

a ventilation system that recycles exhaust air to retain heat, convert small Cushman vehicles to natural gas, and install passive solar skylights in a storage building recycled from Gettysburg National Military Park, Pennsylvania.

In addition, he has acquired a power-assisted bicycle to be used when heavier vehicles are not required and a pickup truck that uses natural gas; in diesel-fueled vehicles he uses biodiesel, made from rapeseed (canola). He has reorganized mowing operations to conserve fuel and staff time, installed low-flow toilets, and uses recycled materials wherever possible.

Greg's environment-friendly practices not only benefit the park, but have also broadened the traditional role of the park from that of being interpreter of local history to being active in the conservation of the Chesapeake Bay watershed. ■

"Partners in Stewardship": Considerations for natural resource stewardship and science in the national parks

By Nina S. Roberts, Ph.D.

CREATING PARTNERSHIPS can be both arduous and enjoyable. Although the concept of partnerships has been around for many decades, the need for them among land stewards has never been greater. Yet new strategies are often required to make the most of what they have to offer. Accordingly, the National Park Service, in collaboration with the USDA Forest Service and other federal land management agencies, hosted the national conference "Joint Ventures: Partners in Stewardship" in November 2003. Held in Los Angeles, this gathering explored ways to create effective partnerships that strengthen ties among communities, nonprofits, educational institutions, and government agencies as the nation strives to develop a more accessible and meaningful network of public parks and open spaces. Many of the ideas are applicable to nurturing partnerships for the scientific management and preservation of park natural resources.



Partners in Stewardship

With more than 270 conference sessions, several major themes were ubiquitous throughout the week. Foremost was that of changing demographics, an indication that institutional change is needed in order for the National Park Service to move in new directions. It was clear to all that the National Park Service cannot continue to operate in the same traditional way. As conference participants affirmed, old thinking, rather than new problems, obstructs change. Additionally, the theme of diversity emerged in many sessions as a critical component of successful contemporary partnerships.

Several prominent figures in government, nonprofits, and the media gave insightful keynote addresses, stimulating new ways of thinking, ideas for the future, and impetus to move ahead. The speakers included Gale Norton, Secretary of the Interior; Fran Mainella, Director of the National Park Service; Lynn Scarlet, Assistant Secretary of the Interior for Management and Budget; and David Rockefeller, Jr., Chairman of the Board of the National Park Foundation. "Keeping it real" was the attitude communicated by Ray Suarez, host of National Public Radio's *Talk of the Nation*. Suarez shared an international perspective of public land use in the United States. Although "we have some of the most spectacular wonders of the world," he said, "we have ... a great challenge to create intergenerational solidarity." The nation is polarized between the haves and the have-nots, and public land management agencies, including the National Park Service, must strive toward greater equity in park access and opportunities for all Americans.

Another prevailing theme was the "power" of partnerships. Fundamental to strong unions are shared interests and concerns of all partners and the opportunity for spontaneity in sharing all viewpoints.

For example, giving skeptics a chance to voice their concerns and interests is powerful and allows a diversity of perspectives to surface and become part of the decision-making process. The key is to preserve relationships and permit partnerships to move in their own direction, at their own pace. Relationships that are forced or strewn with conflicts and dissatisfaction are not conducive to problem solving, whereas shared action can serve all stakeholders.

Partnerships related to marketing and to serving visitor education and park preservation purposes are a growing trend. "People who enjoy special places have a stake in these special places," noted Director Mainella. A current trend is marketing the park experience to diverse ethnic and cultural groups through the tourism industry. Tourism can help establish a meaningful relationship between diverse groups and the parks, a relationship that is underdeveloped and critical to park preservation. Suarez noted that 40 million foreign-born Americans today and millions more in the years to come "don't know your parks yet, don't love them yet, but will if you let them." Analyses of tourism can help organizations like the National Park Service meet the needs of these visitors and engage the interests of nonvisitors alike.

Partnerships in natural resource management and science were highlighted in conference sessions about the cooperative management of federal and private lands, addressing water resource issues at the watershed level, transportation issues, connecting urban populations with forest landscapes, development of the natural resource stewardship curriculum, training wildlife stewards, and others. Several sessions stressed that partnerships must be coordinated to combine scientific knowledge and experiential learning. Some of the innovative education and outreach programs (including coastal ecosystem education) and distance-learning partnerships that were profiled are achieving success. Another important theme was the need to involve academics and researchers in maintaining good scholarship and continuing to incorporate the human dimension of managing public lands. Case studies were presented, small groups interacted, panel presentations engaged audiences, and a full day focused on developing the skills needed for successful collaboration.

In the end, partnerships require compromise and the realization that what may work for one may not for another. Yet partnerships are limited in what they can accomplish only by our imagination.

Further information on the conference and session reports are available on the Web at www.partnerships2003.org. ■

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Place-based science and public-private partnerships key to preserving national parks

By John Dennis

At Director Mainella's request, the National Park System Advisory Board tasked its National Parks Science Committee to review the Natural Resource Challenge and offer recommendations regarding science and scientific resource management in the national parks. The committee submitted its report, titled "National Park Science in the 21st Century," to the Advisory Board in early August and the Advisory Board accepted the report with a request that the committee consider expanding its thoughts about the institutional role of scientists in parks.

The committee's report summarizes the role of national parks, the history and role of science associated with those parks, the trends of changes to natural systems in the 20th century, the dependence of national parks on the presence of functional connections to adjacent lands and waters, the utility of applying land-based concepts of resource protection to ocean resources, and the current status of Natural Resource Challenge implementation. The committee's report offers six recommendations for future directions for national park science. One is to make national parks part of a national system created by biologically linking protected areas. A second is to have the National Park Service contribute its resource protection experience to interagency efforts to improve the protection of freshwater and marine systems related to units of the National Park System. A third is for the Service to draw on its foundation of scientific and traditional knowledge to help improve the scientific literacy of our citizens and to help foster a national stewardship ethic. A fourth is to strengthen the Service's institutional capability for using scientific information in its resource protection activities. A fifth is to show how America's diverse human

cultures have depended on and interacted with the natural world over time. A sixth is for the Service to encourage and work with a virtual consortium of many public and private partners to develop and maintain an electronic encyclopedia of America's natural history.

In conducting its review and offering these recommendations, the committee touched on how the Natural Resource Challenge is meeting its mission and contributing functions that support the committee's recommendations. The committee also offered a vision of what the National Park Service should strive to achieve over the long term. The committee found that the Challenge is embracing creativity through competition, effectiveness through peer review, and accountability and public awareness through rigorous reporting; is increasing the Service's use of science in resource inventory, monitoring, and restoration; and is emphasizing the incorporation of partnerships in all facets of Service activities. These attributes of the Challenge in turn empower the Service to carry out the committee's vision—that each national park serves as a center of enlightenment, that the Service advances the use of place-based science with involvement of a public-private virtual institute for preservation, and that people come to recognize that public enjoyment and protection of the natural integrity of parks are mutually dependent.

The National Parks Science Committee members, Sylvia A. Earle, Robert Chandler, Larry Madin, Shirley M. Malcom, Gary Paul Nabhan, Peter Raven, and Edward O. Wilson, together observed that the vital core of the national park idea is a "broad, inclusive sharing of unique segments of the American landscape with all native species" and that

America's National Park System "represents a profoundly egalitarian concept: landscapes of incomparable beauty and grandeur that are to be shared and enjoyed by all people," a sharing that "would thus extend beyond the human species to all native flora and fauna of the parks." ■

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A sustainable future for the national parks

By Karen Wade



Karen Wade addresses staff at the Intermountain Region General Management Conference, an annual gathering of park superintendents and partners intended to foster collaboration and the development of park management strategies.



looking ahead

Editor's Note: Karen Wade retired in August as director of the Intermountain Region, ending a career with the National Park Service that began in 1960 as a radio dispatcher in Mesa Verde National Park and eventually led to assignments as superintendent of Fort McHenry National Monument and Historic Shrine, Guadalupe Mountains National Park, Wrangell-St. Elias National Park and Preserve, and Great Smoky Mountains National Park. Throughout her career Karen emphasized the importance of developing and nurturing professional relationships and involving local communities in park management dialogue. A visionary, Karen's recognition of the value of inventory and monitoring during the last decade anticipated a time (now upon us) when parks would begin to be understood as places of tremendous biological diversity and not just as scenic destinations. Sustaining these resources, as she suggests in the following essay, goes hand in hand with better integration of the national parks in society, a challenge she understands and expresses as well as anyone.

IN AN ORGANIZATION that at times seems self-deprecating, it is appropriate occasionally to remind ourselves and others of the many things we do right in the National Park Service. Arguably, our most remarkable achievement of the past five years is the successful emergence of solid natural resource programs in parks across the Service. As a consequence, we are seeing the quality of dialogue about how to accomplish resource protection become increasingly sophisticated at a time when such sophistication is necessary to make difficult social and political choices not only in parks but across the landscape.

I think this achievement (the Natural Resource Challenge) is so noteworthy that it should be accompanied by a call for designation of a national holiday each year in celebration of the collective efforts required to preserve our nation's heritage. Few nations in the world have proclaimed such a commitment, sustained it, and made such a sizable, recurring investment. If Americans don't stop occasionally to

"Sustainability ... depend[s] upon the nature of the relationships among business, government, and the community."

remind themselves of that fact, how else will our leaders continue to be challenged to dedicate themselves to the task that never ends ... in perpetuity for future generations?

Why do you think the nation would even consider such an annual occasion? Our founders envisioned stewardship of nationally significant resources *in perpetuity*. The magnitude of that challenge was probably only partially understood at the time and is only just now being evaluated for its meaning within the context of today's society. Yellowstone, we now know, is not sustainable in perpetuity in isolation from the social, political, and ecological considerations sur-

rounding it. Society will ensure protection of Yellowstone or Yellowstone will not be preserved. How powerful is that as a challenge for today and for all time?

With the investment made possible by the Natural Resource Challenge, park staffs now have a better level of understanding not only of resources and their value from an ecological standpoint but also of their value to their gateway communities and to the nation at large. Information collected by us within Inventory and Monitoring

“Yellowstone ... is not sustainable in perpetuity in isolation from the social, political, and ecological considerations surrounding it.”

networks helps transcend artificial boundaries of political and management jurisdictions and creates new collective meaning for all those who are seeking to sustain social, economic, and ecological systems across the landscape. I can see a time when a common database will be accessed to analyze any contemplated land-use change within a given ecosystem. And the appropriateness of the proposal will be judged by its predicted consequence to the sustainability of the whole.

My recent experience has led me to believe that the National Park Service can set the pace, provide the leadership, and use our experience as an example of what can be achieved by employing sustainable practices in all that we do. In collaboration with Dr. Bruce Hutton of the Daniels College of Business at the University of Denver, the NPS Intermountain Region has collaborated to create a National Parks Center for Sustainable Conservation Ethics. The center is developing educational programming based on sustainability themes, researching methodologies for park and program managers to determine which functions are integral to the sustainability of parks, and establishing collaborative partnerships by convening meetings of stakeholder groups to address specific issues. The intent is to help parks solve problems using the principles of sustainability and to ultimately help communities apply these principles as well.

The National Parks Center for Sustainable Conservation Ethics is seeking to understand the fundamental character of the interaction between nature and society as a system. These interactions occur at two levels: (1) interdependency of economic, environmental, and social dimensions; and (2) the impact of this interdependency by the actions of private, public, and nonprofit sectors of society. This is a complex system in which the level of sustainability depends on the decision processes that simultaneously consider all these factors. Balance (and sustainability) depends upon the nature of the relationships among business, government, and the community. Success requires adequate levels of trust, cooperation, and integrated action.

So as we move beyond the fundamentals, we must challenge ourselves to understand heritage resources—both natural and cultural—in

a broader context and see them as factors for consideration by a society of stewards. In such a society, we will all know the value of everything and the consequences of our choices.

Our mission is the right mission. Our vision of the role of parks in society is the right vision. To focus on that, celebrate it, and embrace our responsibilities each new day will help us adapt successfully to the changes that surround us. It will also help us see change from different perspectives so that we do not lose the internal compass that must guide us to do what is “right” each day. When we truly believe we can make a difference, we will make a difference.

And as much as it scares us, we must be willing to trust being on the edge. Being on the edge is where the wind catches us and carries us higher. Being on the edge is where young birds learn to fly, and future generations must learn to fly higher than ever before. With the strength of our convictions, we can be the teachers who help others soar. (The very idea of “national parks” was cutting-edge, and continues to be as that idea has matured. Of the few things that America has “created” of universal appeal, a National Park System is certainly one of the most important.)

“Being on the edge is where the wind catches us and carries us higher.”

I have watched the employees of the National Park Service continue their own self-mastery as they move from being good leaders to significant leaders. I have seen many of them move from the subtle edge of being the best *in* the Service to being the best *for* the Service. They are thermal riders learning to soar with balance and focus. They are putting it all out there and wonderful things are happening. If they continue to look within, they will see more clearly than any of us have seen before. (Author and leadership expert Jim Collins presented the “Level 5 Leadership Theory” in a *Harvard Business Review* article in January 2003. In that article he identifies the characteristics common to Level 5 leaders: humility, will, ferocious resolve, and the tendency to give credit to others while assigning blame to themselves. In my opinion, Level 5 Leadership is exactly what NPS leaders are all about. They have humility combined with an iron will to get the job done.)

As I leave the Service, I’m struck by the fact that one never knows for sure what is an appropriate final destination. Have no doubt that I have learned the journey is well worth the effort and I am still moving on. I am grateful for all the wonderful memories and will always be proud of the men and women of the National Park Service if what they do, they do with a good heart. ■

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